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EDITOR'S CHOICE
★★★★★
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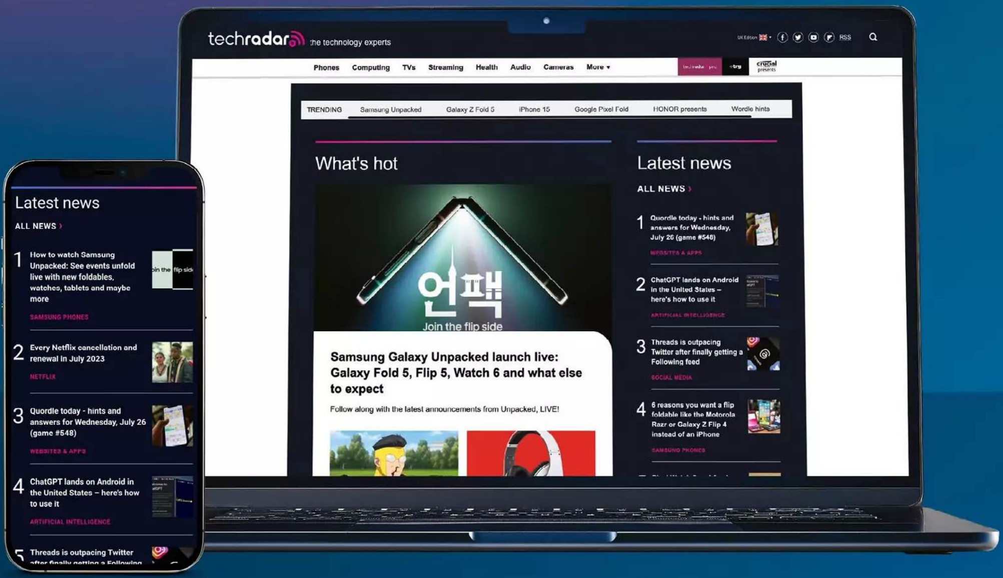
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Guy
Cocker

NO GPU? NO PROBLEM!

IN THIS ISSUE of *Maximum PC*, we've dared to think the unthinkable in performance PC building. Namely, can we build a gaming PC that doesn't have a dedicated GPU? Of course, the GPU market has gone bananas over the last few years, and what was not so long ago the price of a top-end graphics card ($500) has now become the entry price for a decent unit. Intel has tried to plug the gap at the entry-level $200-350 price point with its Arc A750 and A770 cards, and while they got off to a shaky start, the former card is now good enough to feature in our budget builds (see page 96).

AMD, though, has another idea to appeal to budget gamers—a new CPU boasting enough gaming grunt to play modern games at 1080p, eradicating the need for a discrete graphics processor at all. Our master builder Zak, coming hot off a three-issue streak of builds using Nvidia's high-end RTX SUPER cards, has been brought down to earth by the challenge of building a gaming PC that costs under $800. The chip at the heart of this machine is the new Ryzen 5 8600G, which packs in dedicated graphics processors that even include ray accelerators. As Zak says in the feature, it's "effectively 25 percent of an RX 7600" packed inside a traditionally sized CPU, which opens up lots of interesting possibilities for eSports players, or those who just want to do some casual gaming every now and then.

This being Zak, he didn't just build a budget machine and try a bit of *Overwatch 2* though; he also built machines running a Ryzen 5 7600X paired with an Intel Arc A750 GPU (still for under $1,000), and another with an RX 7600 XT ($1,100). He then ran over 80 benchmarks to see which offered the most frames per dollar, and therefore the best value for money. The results are really interesting—our cover feature starts on page 16.

As I'm sure you're aware, 'artificial intelligence' is the buzz term of 2024. It's made Nvidia one of the most valuable companies in the world, and consequently, practically every press release that hits my inbox features "AI" throughout. This issue, we cut through the noise in our feature AI PCs: What You Need To Know (page 32). Are these PCs worth buying, what can they do for you, and most importantly, how much are they going to cost? We also talk you through the best of Photoshop's new AI features (page 60), so you can seriously improve your photo editing and graphic design skills without having to pay hundreds of dollars to go on a course.

We also have a couple of security focused features this issue, from how not to get hacked (page 54) to building your own VPN (page 48). I've learned a lot from them both, and will no longer be quite so blasé when I connect to the internet at a coffee shop or airport.

Last of all, we have our review of the RX 7900 GRE, or 'Golden Rabbit Edition' (page 74), a model that has escaped captivity in China, where it was previously exclusive. It's a small spoiler to say that our GPU specialist liked what he saw, with AMD bringing some real competition to Nvidia's similarly-priced RTX 4070. So obviously, next issue's build will be with the GRE card, pitted against an RTX 4070 build from a previous issue. I can't wait!

Enjoy the issue!

Guy Cocker

Guy is Maximum PC's *editor-in-chief. He built his first gaming PC in 1997 to play* Tomb Raider *on 3dfx, and has been obsessed with all things PC ever since.*

↘ submit your questions to: editor@maximumpc.com

THE NEWS

Intel announces 6th Gen Xeon brand

'Xeon Scalable' becomes the Xeon 6 series

THIS YEAR at Intel's 'Vision' event in Phoenix, Arizona, the tech company focused on bringing business and technology leaders together to learn about AI advances.

It also announced that the 6th generation Granite Rapids and Sierra Forest processors will be branded 'Xeon 6', dispensing with the 'Fifth-Gen Xeon Scalable' naming convention. In Intel's words, the "evolved" Xeon 6 branding will "tell a unified Intel Xeon story," "facilitate customer navigation", and "amplify performance signals."

Intel's product stack consists of 32 models divided into six lanes for cloud, networking, and so on, plus the Bronze, Gold, Silver, and Platinum tiers. At the time of writing, it's not clear how the introduction of Xeon 6 Sierra Forest processors will clarify the current lineup of CPUs. Intel first unveiled its 288-core Xeon CPU in September 2023. In late February 2024, it began previewing it for the AI processing industry.

CEO Pat Gelsinger displays wafers of both Xeon 6 Processors.

© INTEL

On the 'performance signals' front, however, the Sierra Forest data center chip will be the first to be built solely with efficiency cores (E-cores), which are optimized for cloud-native and scale-out workloads. The company claims this will boost performance of 5G workloads by 2.7 times per rack, as well as 2.4 times per watt relative to 2nd generation Xeon processors.

This means 72 Sierra Forest server racks could provide the same performance as 200 racks with older 2nd Generation Xeon CPUs, possibly providing space and power savings for data centers. Sierra Forest supports both single- and dual-socket systems, and Intel claims the chips will have a TDP as low as 200W. It is scheduled for the second half of 2024.

> Both variants will have the same chiplet-based design, sockets, and firmware

Granite Rapids architecture is the successor to 'Emerald Rapids'. Both variants will have the same chiplet-based design, sockets, and firmware. They also house DDR5-6400 memory controllers on both ends of the die, offering up to 12 channels (1DPC or 2DPC) of either standard DDR memory, or the latest MCR, providing 30-40 percent more bandwidth than standard DIMMs.

Granite Rapids chips will use only performance cores (P-Cores). They will be more of a traditional data center processor, given that the P-Cores are capable of maximum performance using the company's fastest architectures.

Each P-core comes with 2MB of L2 cache and 4MB of L3. Intel has announced a new architecture dubbed Redwood Cove for these that comes with an L1 cache of 64Kb. Floating point performance has also been upgraded through moving from 4- and 5-cycle FP operations to 3 cycles, boosting IPC. It also employs software-optimized prefetches, plus an enhanced branch prediction engine.

The number of Granite Rapid processor cores hasn't been confirmed, but a supposedly leaked slide from Intel had the core count as 128. It also claims the chip will have a TDP of 500 Watts. These would make Granite Rapids the first Intel server CPU architecture to outstrip AMD's EPYC (Genoa) series.

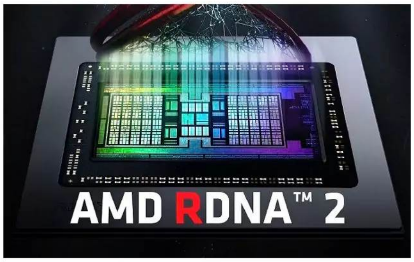
The chips will also support the MXFP4 data format. This can reduce next-token latency by up to 6.5 times, compared to 4th Gen. The company also claims the processors are capable of running 70 billion parameter Llama-2 models.

Granite Rapids will have 2.8x memory bandwidth compared to previous generations, as well as an improved core count and cache. The platform supports up to eight sockets. However, the 500 W TDP raises questions about whether cooling systems can keep up.

Though no official date has been announced, Intel says Granite Rapids is due to arrive 'soon after' Sierra Forest, with an estimated release date of late 2024/early 2025. **–ND**

RDNA 2 GPU STOCKS LOW

6950 XT, 6900 XT, & 6800 XT SPARSE



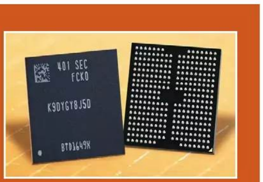
WITH AMD'S RDNA 4 GPUs rumored for the end of 2024, there's little room for AMD's previous-gen RDNA 2 cards.

The series launched in 2020, and the 16GB AMD Radeon RX 6800 XT was considered one of the best graphics cards of its time. Unfortunately, it was almost impossible to purchase at its original retail price. In recent weeks, history seems to be repeating itself.

Used RDNA 2 series graphics cards are still available via auction sites, though in some cases for well above the original retail price. Lower-end GPUs like the Radeon RX 6750 XT are also still available for around $330. AMD's higher-end RX 7000-series, such as the RX 7900 GRE and RX 7900 XT, are also still available at reasonable prices. **–ND**

SAMSUNG BUILDS 9TH GEN V-NAND CHIPS

Samsung begins producing next-gen memory chips for SSDs



SAMSUNG HAS BEGUN mass-producing its 9th-generation triple-level cell (TLC) vertical NAND memory chips for high-performance/high-density solid-state drives. They are smaller and have an improved bit-density of 50 percent compared to the Samsung's 8th-generation V-NAND. They will also have 290 active layers—a 20 percent improvement on previous generations.

This should enable Samsung to increase recording density of its 3D NAND devices. According to a report by Hankyung Media, Samsung plans to build on this by introducing a 10th Generation V-NAND chip in 2025 with 430 layers. It also says that Samsung has achieved this through a 'string stacking production technique': building a CMOS layer with logic, a 145-layer 3D NAND memory array on top, then successive identical layers on top of that.

Other NAND manufacturers have been quick to exploit new techniques. SK Hynix will begin production of 321-layer chips in early 2025, with 430 layer versions due later the same year. **–ND**

Tech Triumphs and Tragedies

A monthly snapshot of what's good and bad in tech

TRIUMPHS

TIKTOK BAN PASSED
The US government has approved a ban, citing privacy and security concerns.

8K META QUEST
YouTube videos via Meta Quest are now better quality, due to the app supporting 8K streaming.

BATTERY CHARGES UP
European researchers have developed a charging solution to make li-ion batteries last longer by altering how the charger delivers current to electrolytes.

TRAGEDIES

MESSAGE APPS REMOVED
Apple has removed WhatsApp, Telegram, Signal, and Threads in China at the request of the Chinese government.

MITRE ATTACKED
Hackers have used Ivanti devices to access one of MITRE's unclassified networks.

MAJOR WINDOWS FLAW
An attack relies on 'Magicdot' paths, where functions convert DOS to NT, allowing hackers access to Windows machines.

© LG, SAMSUNG, AMD

LG ANNOUNCES GAMING OLED

The panel can alter refresh rates and resolutions

LG DISPLAY has developed the first ever gaming panel with a switchable refresh rate and resolution. This is achieved through the company's 'Dynamic Frequency and Resolution (DFR)' feature.

Mass production is already underway. In theory, this will allow users to choose between a high refresh rate (posited by LG as FHD·480Hz) and a high-resolution mode (UHD·240Hz).

The company says that given a high refresh rate allows the panel to display more images per second, this is most useful for games where speed and screen changes are particularly important.

The UHD high-resolution mode is designed for graphically rich content like 4K movies, given the more pixel-perfect video and image quality. At 480Hz, LG claims the panel has the fastest response time (0.03ms) of any panel on the market.

LG has also incorporated a number of other improvements to image quality in their latest gaming panel. This includes META Technology 2.0, which is based on the company's Micro Lens Array (MLA).

According to LG, this "maximizes the emission of light from organic materials to elevate image quality." In other words, it makes the OLED panel brighter. This offers some of the advantages of LCD tech, given that OLED produces less blue light.

Although this will first be deployed in the 31.5-inch mode (most likely the 'Ultragear' series), LG plans to mass-produce other sizes, including 27, 34, 39, and 45 inch.

LG's OLED panel is also built into the 32-inch ASUS ROG Swift PG32UCDP WOLED monitor (showcased at CES), with a provisional release date for 2024.

Asus has also claimed that thanks to LG's WOLED panels, its upcoming monitor can reach 1,300 nits peak brightness—a 30 percent increase on their previous OLED monitors peak of 1,000 nits. Pricing and availability are still to be confirmed. **–ND**

EX-ARM CHINA CEO FOUNDS RISC-V

Firebrand Allen Wu courts controversy in his latest venture

ARM CHINA'S EX-CEO Allen Wu shot to fame after refusing to step down despite being fired by the company in 2020 and again in 2022. His actions meant that parent company SoftBank Group couldn't perform financial audits for around two years. Eventually, a combination of corporate maneuvering and tacit assistance from the Shenzhen government resulted in Wu being ousted in 2023.

According to WeChat account 'Chip Inside', Wu is founding a company named 'Zongzhi Chip'. This is rumored to be actively recruiting both RISC-V professionals and Arm China employees.

According to 'Chip Inside', ZongZhi Chip's purpose will be 'technology innovations focused on RISC-V processor IP and computing platform solutions.' Market tracker TrendForce has also reported rumors that the company will act as a representative for AI and RISC-V startup 'Tenstorrent' in China.

Although this has not been officially confirmed, the company has a history of forming partnerships to ship new products. One recent example is its use of Samsung's SF4X technology for its Quasar chiplet for machine-learning workloads. The chiplet is tailored to run AI workloads and contains a minimum of 80 Tensix cores based on the RISC-V instruction set.

According to TrendForce, Zongzhip Chip has backing from "abundant resources and shareholders with strong competence", and even partnered with several "stellar global RISC-V chip companies".

TrendForce claims the company is maintaining a neutral stance on technology, which it believes will support the growth of Chinese domestic applications.

Wu throwing his hat into the ring with Arm's 'archrival' may give the tech giant cause for concern. Still, the current reports don't detail which specific partnerships have been formed and which specific RISC-V products Zongzhi Chips plans to float or back. **–ND**

Fire risk triggers recall of cat robots

SEGA TOYS released its line of 'Kimit' toys in February 2024. The cat robots were supposedly trained on the data of over 100 cats, and can mimic typical feline behavior.

This innovation, which cost ¥33,000 (around $215), seems more expensive than adopting a cat, but Sega Toys was aiming at customers who were allergic to the real thing. This is quite a problem: a survey by Tokyo-based LG Electronics Japan in 2023 revealed that 12.5 percent of cat owners have an adverse reaction to their own pets.

A series of adverts in Japan showcased the robots' ability to make their eyes glow as users cuddled and petted them. The 'ragdoll' cats were also shown to be warm to the touch, with realistic-looking fur, which is apparently what triggered the recall.

According to various outlets, Sega began recalling the Kimit models in response to customer feedback that they could smell burning. The cause was traced to an internal control motor, charring fabric that came into contact with the motor cover.

Sega has pointed out that there are no documented cases of the cats catching fire, nor has anyone been injured. However, all models have been recalled, and customers who previously purchased a Kimit cat have been refunded in full.

Disappointed buyers can console themselves with the fact that Japan is home to over 300 cat cafes, where they can pet feline friends while they enjoy a beverage. **–ND**

The Kimit commercial shows cats being nonplussed by the toy.

© KIMIT JP

Russian group exploits Windows print spooler bug

Microsoft Threat Intelligence researchers have claimed that a malware code named 'GooseEgg' is being used by cyber espionage group APT28 (aka 'Forest Blizzard') to exploit a Windows print spooler bug.

GooseEgg exploits vulnerability CVE-2022-38028 in the Print Spooler service to modify a Javascript constraints file, then execute it with SYSTEM-level permission. Although it is a simple launcher application, it can launch other programs.

Microsoft's Security blog states that the GooseEgg vulnerability has been patched since October 2022. Two more patches have since been released for print spooler flaws.**–ND**

AI could consume 25% of all US electricity

Arm's executive Ami Badani has warned that generative AI's "insatiable demand" for electricity could hamper its growth.

Speaking at the Fortune Brainstorm AI Conference, Badani stated that chatbots account for two percent of global energy consumption, and require, "15 times more energy than a traditional web search." At this rate, she says that by 2030, AI will consume a quarter of all power in the USA.

A recent AI success story is Sora, which can create 60-second video clips based on text prompts. It's also an excellent illustration of Badani's warning, given that it takes 100,000 AI chips working at full capacity to train. **–ND**

Jarred Walton

TECH TALK

Intel Raptor Lake Core i9 Instability Problems

THE RACE BETWEEN AMD AND INTEL has heated up in the past few years as Ryzen processors have become increasingly competitive. The amount of headroom for overclocking has shrunk in response, and it seems motherboard vendors may have tweaked settings a bit too aggressively.

The result, according to numerous accounts on forums, has been out of VRAM errors and other instabilities. My particular PC has also experienced problems. While my own CPU issues date back over a year, it seems a number of games are triggering 'out of VRAM' error messages, particularly on Nvidia GPUs. But the graphics card has nothing to do with the games crashing to desktop.

RAD Tools, which provides software libraries, released a statement about crashing problems: "RAD has become aware of a problem that can cause Oodle Data decompression failures, or crashes in games built with Unreal. We believe that this is a hardware problem which affects primarily Intel 13900K and 14900K processors, less likely 13700, 14700 and other related processors as well. Only a small fraction of those processors will exhibit this behavior. The problem seems to be caused by a combination of BIOS settings and the high clock rates and power usage of these processors, leading to system instability and unpredictable behavior under heavy load."

Perhaps most importantly, it doesn't affect all Raptor Lake CPUs. If you were to swap between two Core i9-14900K chips, one might work fine while another crashes. Some have suggested that Intel released 'faulty' chips, but that's not the entire story. There are multiple workarounds, including underclocking, voltage tweaks, limiting the power and/or current the chip can draw, and more. Nearly all fixes involve digging into your motherboard BIOS settings, which can be intimidating for the uninitiated. The problems exist even with the default BIOS settings.

Intel's 13th and 14th Gen i9 CPUs have faced stability problems.

> How widespread the issues are isn't clear—some suggest that thousands of chips are affected

My CPU and motherboard have generally worked well with the CPU power limited to 325W, combined with a maximum thermal setting of 90 C. I may have lost performance, but games that would otherwise crash during shader compilation were fine. Impacted games include *Hogwarts Legacy*, *Horizon Zero Dawn*, *Metro Exodus Enhanced Edition*, and more.

Some users suggested looking into Load Line Calibration (LLC). LLC works to prevent instability with changing voltages. As chips alter their frequencies, it's possible for voltages to drop below the necessary level for a fraction of a second. This appears to be what's happening with certain Raptor Lake chips. The default MSI settings in my case use a value of 50 for 'CPU AC Loadline' that's buried in the BIOS. Changing this to 70 causes more voltage to be delivered in certain situations, which also seems to fix things.

How widespread the issues are isn't clear—some suggest potentially thousands of chips are affected. That might seem like a lot, but for a company that ships millions of CPUs a month, it's a drop in the bucket. Since there's some luck involved, simply RMA'ing the CPU might be easiest. But if you'd rather not deal with that, you may need to dig around through your motherboard options to look for the LLC settings.

Ultimately, this has felt a bit like the auto-overclocking features used in motherboards for many years. In theory, getting higher performance sounds good. In practice, if it's not fully stable, most people would rather lose a tiny amount of performance than redlining a chip. It'd be nice if all the involved parties here, Intel and the motherboard vendors, would stop the shenanigans and ship with default settings that just work.

Jarred Walton has been a PC and gaming enthusiast for over 30 years.

THE LIST

THE BEST GAMING LAPTOPS

THE LATEST GENERATION of mobile GPUs and CPUs are now well established. That means prices are down from their peak, when all the hardware was new. At the same time, it'll likely be a year before any significant chip updates arrive. This means that now is a great time to grab a great gaming portable at a sensible price, without having to worry that it will be hopelessly outdated a few months later.

PREDATOR
NVIDIA G-SYNC
intel CORE i7
GEFORCE RTX

5 ACER PREDATOR HELIOS 16

Considering this laptop is quite a bit cheaper than its RTX 4080 competition, it doesn't feel that pared back for it. In fact, this laptop has one of the most gorgeous screens we've seen on a mobile device yet, powered by mini-LED and running at 240Hz. The overall gaming performance is a little off the pace of the rest of the pack, but this is still a high-end laptop that can deliver immense frame rates. Even if the chassis construction is a little plasticky, it's still a very sleek, stylish machine with plenty of ports. **$1,969, www.acer.com**

4 ASUS ROG ZEPHYRUS G14

If a 15-inch machine is too big for your lap, then this is the notebook for you. It's a lovely little device with a gorgeous screen, solid specs, and tons of connectivity. The new design for 2024 is absolutely gorgeous, too. The new all-metal build feels great, looks great, and trims down the footprint of the Zephyrus G14 to an even more travel-friendly 1.63cm at its thickest point. Oh, and the OLED screen is killer with an excellent breadth of color and contrast, plus an increased resolution of 2,880 by 1,800. **$2,000, www.asus.com**

3 RAZER BLADE 15

The Blade 15 is that holy grail of gaming laptops, with MacBook aesthetic meeting desktop gaming prowess. They're lovely things of anodized black aluminum, with some seriously powerful gaming hardware. Our pick for the best gaming laptop, the 16-inch Lenovo Legion Pro 7i, is about $200 cheaper than the RTX 4070 SKU of the Blade 15, but comes with a much faster RTX 4080. If you can afford it, this is one sweet portable. **$1,999, www.razer.com**

2 GIGABYTE G5

By simply dropping either the RTX 4060 or RTX 4050 into its last-gen chassis, Gigabyte has created the most affordable, most powerful budget gaming laptop around. It's a great mix of value and gaming silicon. There's plenty of good things to say about the screen on the G5, too. It's vibrant and responsive, and while 1080p over 15.6 inches doesn't make for the best pixel density, it's still a happy median for frame rate, resolution, and size. This is definitely tough to beat for the accolade of best affordable gaming laptop to buy right now. **$1,100, www.gigbyte.com**

1 LENOVO LEGION PRO 7I

This is the best gaming laptop from all the new machines this generation. It's also the best 16-inch notebook, which is our new favorite form factor, with the best screens we've seen in modern laptops. It comes in at a price that makes the rest of the high-end RTX 40-series look a bit ridiculous. It's the RTX 4080 model that really impresses, offering the sort of gaming performance that will have you questioning why anyone would want an RTX 4090. **$2,099, www.lenovo.com**

240Hz
NVIDIA GEFORCE RTX 4080
intel CORE i9
Lenovo

© ACER, ASUS, RAZER, GIGABYTE, LENOVO

Jeremy Laird

TRADE CHAT

What exactly is an 'AI' PC?

AI, EVERYWHERE, all at once. That, in a nutshell, is what's happening to the computing industry. The PC, inevitably, is not immune. Later this summer, you'll be able to buy a machine that officially qualifies as an 'AI' PC, according to no lesser an authority than Microsoft. But you might be surprised at who's making it.

The whole AI industry is, slightly ironically, tricky to compute. What does 'AI' actually mean? When do a few clever algorithms and a dash of pattern spotting actually become artificial intelligence in a meaningful sense?

Right now, there's debate over the possibility of sentience of the latest chatbots. Personally, I don't think text prediction amounts to intelligence, much less sentience. Large language models are *meant* to do a convincing job of predicting text, and do just that, which is not cause to impute some mysterious higher function emerging out of nothing.

That may happen eventually. In the meantime, we have the term 'AI' plastered all over everything. Later this year, that will include the PC. Microsoft is obviously one of the most important players in PC tech, so what it determines should make for an AI PC will become something of a de facto standard.

Unsurprisingly, Microsoft has decided that an AI PC needs to be running its Copilot AI assistant. Somewhat fatuously, an AI PC, according to Microsoft, will also need to have a physical Copilot button on the keyboard. Perhaps a sticker over the right-hand Alt key and a quick remap will do.

Also, a Microsoft-endorsed AI PC must have an NPU or Neural Processing Unit with at least 45 TOPS (Trillion Operations Per Second) of processing power. It's not clear where that figure comes from, but it's likely it wasn't reached without consulting with the likes of Intel and AMD.

It is therefore precisely no surprise at all that Intel's next-gen mobile CPU, codenamed Lunar Lake, and due out by the end of the year, will offer—you guessed it—precisely 45 TOPS from its second-gen NPU. Intel's latest Meteor Lake laptop CPUs also have a dedicated NPU for AI processing, but it only offers 11 TOPS of performance.

As for AMD, its Hawk Point has a slightly more powerful NPU at 16 TOPS, but that's still well short of what's required to qualify as an AI PC. And wouldn't you know it, AMD says its upcoming Strix Point chip for laptops will have three times the NPU performance of Hawk Point, putting it just over that 45 TOPS target. What a coincidence.

However, there's a good chance that the first PCs to qualify for Microsoft's AI definition might well be powered by a chip from neither Intel nor AMD. In fact, the first AI PCs might not be traditional x86 PCs at all. Instead, they'll be powered by Qualcomm's new Snapdragon X Elite Arm SoC.

© INTEL

Can you guess how many TOPS the NPU in the X Elite cranks out? I bet you can. Once again, it's the magic 45 TOPS figure. The first laptops with the X Elite are due to go on sale in June. That's definitely long before Intel will have any Lunar Lake laptops on the market. Intel says Lunar Lake is a 2024 product, but odds are it'll barely be available by the end of the year.

By my reckoning, those X Elite portables are likely to beat AMD's Strix Point to market, too. Anyway, I suspect Microsoft will want to make a big splash with the arrival of those first 'A' laptops, which will make for nice PR for Qualcomm. I think it's unlikely that the X Elite will be a smash hit, but it could still turn out to be a key inflection point for the PC's transition from x86 to Arm. If so, chalk that up as yet another achievement for AI. It's writing your emails, planning your meetings, faking your photos, and now, it's turning your PC into an Arm machine.

> Intel's CEO recently showed off the company's first AI chip

Six raw 4K panels for breakfast, laced with extract of x86... Jeremy Laird eats and breathes PC technology.

DOCTOR

THIS MONTH THE DOCTOR TACKLES...

> Better NAS mobo?
> Explorer crashes
> Speed up Handbrake

Alternative N100 board

In your article on building a NAS system in the April 2024 issue, two possible N100I motherboards were mentioned. In doing research on the components in the system, I came across a third possibility, the IKuai OS N100 ITX motherboard. Looking at the specifications, it seems like a much better fit for your NAS build. Some advantages over your choices are that the IKuaiOS has six SATA ports, four Ethernet ports, and two M.2 ports built into the motherboard. It does lack audio output, but I don't think this is a problem for a NAS server. Using the iKuai OS board would seem to eliminate the need for the M.2 SATA card, the Ethernet card, and the SATA SSD drive (an M.2 SSD would replace it and there'd still be another M.2 slot available). An extra SATA port would be available for an optional SATA SSD drive if desired.

Currently, the iKuai OS N100 ITX motherboard is available from both iKuai's website and Walmart for $138 and $135 respectively. IKuai also offers a package deal of the board plus a 16GB RAM chip and a 1TB M.2 SSD for $276. I don't know the brands of the RAM and M.2 SSD included. My question is: would this motherboard work with your design and be a better and cheaper fit than your choices? How about popping one into your April NAS build, testing it, and letting us know the results?

—James Snell

The BKHD 1264-NAS-MB features six SATA ports.

THE DOCTOR RESPONDS: The iKuaiOS board you refer to is manufactured under another brand name—BKHD—with the product name 1264-NAS-MB. You can access its official website at www.bkipc.com/en/product/1264-NAS-MB.html for a detailed description and access to both a manual and a single BIOS update, dated December 21 2023.

On closer inspection, both iKuaiOS and BKHD are brand names for Guanfeng Network Technology (Shenzhen) Co Ltd, a Chinese company operating out of Shenzhen in mainland China. This is an important caveat, as we don't know much about this manufacturer—what support is offered, and whether it offers a US point of contact, should you need it. These considerations should be factored in before taking the plunge.

That said, the spec is certainly impressive, and had the Doctor been aware of this board when building the NAS for the April 2024 issue, he'd have almost certainly given it serious consideration. As you say, this board simplifies the building of a NAS by eliminating the need for the additional components we added to our build to double network throughput and add extra SATA ports for storage. We also like the 1264-NAS-MB's layout, as it fits the Jonsbo N2 design much better than our ASUS PRIME—the power connector is right over by the PSU, eliminating the need for a long 20+4-pin cable. The SATA ports are also logically placed within easy reach of the SATA backplane along the right-hand side of the case.

The DDR5 SO-DIMM slot is also a step up from the DDR4 slots found on both ASUS and ASRock boards, but the Doc feels the four 2.5Gbps Ethernet ports are overkill and betray the board's more obvious appeal to the industrial market. That said, it's clearly capable of powering a home server/NAS, and online comments seem to bear this out.

Reading through these reveals some more caveats to consider. One user reports being unable to boot from a standard SATA SSD drive, so you'll have to fit at least one M.2 drive. Others report dissatisfaction with the CPU fan control, which they say runs at full speed despite their best efforts to set it dynamically in the BIOS. We also wonder if the onboard CPU fan isn't overkill, given how quiet and cool our ASUS PRIME board runs (around 40-45C most of the time)—do you need that extra noise?

Ultimately, it comes down to personal choice.

↘ submit your questions to: doctor@maximumpc.com

The Doc is happy with his ASUS PRIME setup, which has been running smoothly and quietly for a month now with no apparent ill-effects. However, we'll see if we can track down one of these boards to review in a future issue. Watch this space.

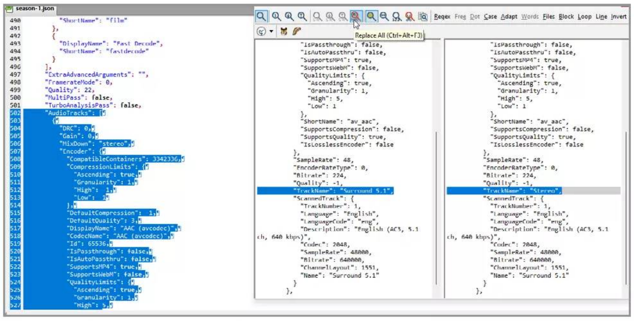
Explorer keeps restarting

I've been plagued with a strange thing whereby if I attempt to access File Explorer then it keeps crashing and restarting, taking the Taskbar and some other desktop elements with it. I've looked in Event Viewer, and can see lots of Application errors relating to 'Faulting application name: explorer.exe'. They also reference a module name—many refer to ntdll.dll, but one also references NCContextMenu.dll_unloaded. Can you help me determine what the cause is, and how to fix it?

—Jeremy Devito

THE DOCTOR RESPONDS: NCContextMenu.dll can be traced to the Nextcloud client, and a quick Google search reveals it to be a known bug in Nextcloud 3.12.2. Nextcloud has now issued an update (3.12.3), which resolves that particular crash, so the obvious solution is to update. Had we still been waiting on this update, the Doc would have advised either rolling back to the previous version, or using ShellExView (www.nirsoft.net/utils/shexview.html) to disable all Nextcloud entries.

If a culprit hadn't been identified, we'd have recommended using Autoruns to identify what extensions are loaded with File Explorer. Download and run the tool as an administrator from https://learn.microsoft.com/en-us/sysinternals/downloads/autoruns and then switch to the Explorer tab. You'll likely see loads of entries related to various programs you've installed. You could try disabling the lot to see what effect that has on File Explorer's stability—you'll notice it's a bit more responsive, if nothing else, but you might also fix the underlying problem. If it did, you'd have to re-enable items one at a time or in clusters until the crash resurfaced, allowing you to identify the cause and take action. That might be looking for an update or fix, removing the program, or leaving it disabled if the problems don't run deeper.



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        }
      },
```

You can directly edit Handbrake queues as .json files.

Handbrake shortcut please

While Handbrake is fabulous, I find it lacking in one area: being able to set templates for audio and subtitle track names. When I'm ripping large numbers of files with identical audio and subtitle setups, it's frustrating having to enter the title (such as 'Stereo' for a mixed-down 5.1 Surround track, or 'Director's Commentary' for a commentary track) for every title. Is there a way to apply one set of audio and subtitle settings (including track titles) to all titles in the queue?

—William E Lewis

THE DOCTOR RESPONDS: If you're willing to play around with JSON files, you can develop a technique that over time will prove quicker (and less likely to induce madness!) than manually inputting the same details over and over again.

Start in Handbrake. Add your source and set it up as normal, naming the audio and subtitle tracks as you want them to appear. Click 'Add to Queue'. Now, press Ctrl + Alt + A to add the other tracks to your queue, clicking Yes to skip the track you just set up, and add the rest. Now, click Queue, where you can confirm the first track is set up correctly, but the others haven't been.

Click the Options button and choose 'Export Queue'. Save the file with a .json extension. Now, open a text editor that supports multi-line search, such as EditPad Lite (www.editpadlite.com). Load your .json file and you'll see it's basically a long line of scripted code. Next, select 'Search > Multi-Line Search Panel' to open the panel.

Scroll down a few hundred lines into the code (anywhere from 300 to 600), where you should find a section beginning 'AudioTracks'. This is where the track information for the first title you set up can be found. Each audio track takes up around 50 lines of code and ends with '},'. Use the 'TrackName' identifier in this code to confirm the track is the one you want to use. Copy and paste this block into the Replace box on the right of the Multi-Line Search panel.

Now, scroll down to find the equivalent track from your second title—it's around 800 lines below the first block. It should be identical in every way, except for the tell-tale TrackName identifier. Copy the same block from here into the left-hand pane. Click inside the main EditPad window to deselect the text. You should find it highlighted in yellow to indicate it's a match.

Once you've verified that the Search and Replace panes are identical, except for the all-important TrackName identifiers, click the 'Count Matches' button (the blue magnifying glass icon with 123), which should confirm that the number of found matches are the number of titles in your queue, minus the first one. To make the changes, click 'Replace All' (the red magnifying glass with the R letter inside it).

Once done, press Ctrl + S to save the file. Return to Handbrake, click Options, followed by 'Clear All' and Yes. Click Options again, but this time choose 'Import Queue' to import your amended .json file. You should be able to go through the queue and confirm that each title now has the correct audio and subtitle track names assigned to it.

It feels like a convoluted shortcut, but once you're familiar with it, you'll realize it's a process that takes just a minute or two, and is much quicker and less arduous than processing large queues by hand.

Joplin so sluggish

Why does my portable installation of Joplin take so long to load? After opening the shortcut, it takes up to a minute before it suddenly opens.

—Robert T Mills

THE DOCTOR RESPONDS: This is traced to the way the portable application works: it must decompress and unpack Joplin into memory from the portable app file, which is why it's slow to start. Try installing it instead and seeing if that improves things—you should find it now launches in a matter of seconds; if not, get back in touch and we'll dig deeper.

THE BATTLE OF THE BUILDS

DEDICATED VS INTEGRATED GPUs

We put AMD's latest Ryzen 5 8600G to the test

PC GAMING has come a long way in the last 20-30 years. Let's be fair—it has never been a cheap hobby. Consoles have and always will be cheaper than any PC you can buy or build, no matter what generation. In fact, over the years we've tried numerous times to forge the ultimate budget rig, only for it to still be more expensive than its console counterparts, and lacking performance somewhat as well (although admittedly that's because PCs have better graphical fidelity as standard).

It's a tale as old as time. But lately, with the cost of hardware climbing upward, it feels like getting your foot in the door for a decent PC gaming experience is starting to become almost impossible. Once upon a time, our budget builds were $400-500. Now, they average close to $1,000, if not more when including a dedicated GPU. Take a look back at the GTX 900 series—the 980 debuted at an RRP of $550, and the latest RTX 4080 hit the market at $1,200. That's a 118 percent increase in the flagship GPU price in just eight years.

Is it all lost, then? Is humble PC gaming now out of reach for a large majority? Well, it got us thinking, and with AMD launching its latest batch of Ryzen 8000 series CPUs, complete with radically impressive integrated graphics performance, we decided to put its most entry-level chip to the test in a somewhat budget $700-800 gaming PC grudge match.

All of this would be fairly moot without a good comparison, though. To really take this build and feature to the next level, we're including two 'alternate endings'. By stripping back our budget build, integrating one of our favorite CPUs, and combining that with two of the best budget GPUs around, Intel's Arc A750 and AMD's RX 7600 XT, we're pitting the two styles of system against one another to see what that extra GPU investment might net you.

CORE PARTS

		PRICE
CPU	AMD Ryzen 5 8600G	$229
Mobo	Gigabyte B650M Gaming X AX	$225
CPU Cooler	Be Quiet! Dark Rock Elite	$100
RAM	16GB (2x8GB) Kingston Fury Beast DDR5 @ 6000 C36	$76
SSD	500GB Samsung 980 M.2 PCIe 3.0 SSD	$66
Case	Phanteks XT Pro Mid Tower	$50
PSU	Corsair CV450 80+ Bronze	$45
TOTAL		**$791**

INTEL GPU ALTERNATIVE

		PRICE
CPU	AMD Ryzen 5 7600X	$208
GPU	Acer Predator BiFrost OC Arc A750	$200
TOTAL		**$971**

AMD GPU ALTERNATIVE

		PRICE
CPU	AMD Ryzen 5 7600X	$208
GPU	Gigabyte Gaming OC RX 7600 XT	$330
TOTAL		**$1,101**

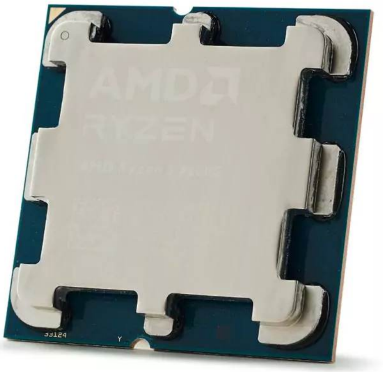
PRICES CORRECT AT THE TIME OF PUBLICATION

https://content.jwplatform.com/videos/mYuMeh0J-u2lN49He.mp4
Please type this URL into your browser if the link is broken

DO IT YOURSELF!
STEP-BY-STEP GUIDE
PG. 22

ZEBRA
CORSAIR
CV450
RADEON
GIGABYTE
GIGABYTE
GAMING
Socket AM5
be quiet!
SAMSUNG SSD
KINGSTON FURY BEAST DDR5
KINGSTON FURY BEAST DDR5
AMD RYZEN
AMD RYZEN

CORE HARDWARE PICKS



CPU

AMD Ryzen 5 8600G

$229, www.amd.com

AMD's Ryzen series has, without a doubt, been an absolute hit. Its top-tier performance, incredible efficiency ratios, and stellar componentry has made it an absolute shoo-in for one of the best CPU architectures to date. It has pushed Intel's own processors to the absolute limit from a competition front, and really helped AMD claw back even more market share.

The 8000 series, recently launched as an alternative to AMD's Ryzen 7000 series desktop line, comes with dedicated iGPU componentry, specifically designed with gaming in mind. The 7000 line does have integrated graphics, utilizing two CUs pulled from the RDNA 2 GPU architecture, but it's incredibly limited at a 2.2 GHz boost. The 8600 and 8700G, on the other hand, both benefit from eight and 12 CUs respectively of RDNA 3.0 (the same architecture found on the latest 7600 series GPUs and above), clocking up to 2.8 and 2.9 GHz.

In the other mainline specs, the 8600G packs in a total of six CPU cores, 12 threads, a maximum clock speed of 5 GHz, and 16MB of L3 cache on top. On the GPU side, you get eight CUs, featuring 512 shader cores, 32 TMUs, and 16 ROPs, and it even comes with 16 ray accelerators, as well as eight AI accelerators, giving it ray-tracing and AI upscaling capacity, too. It's effectively 25 percent of an RX 7600, but with added CPU cores attached. The only downside is a lack of dedicated PCIe lanes for the GPU, as both chips only come with x8—not x16, as you'd find on the desktop.

SSD

500GB Samsung 980 M.2 PCIe 3.0 SSD

$66, www.samsung.com

It feels like an eternity since we've seen any new high-speed M.2 SSDs come out of the Samsung foundries, but that hasn't stopped them developing some incredibly effective budget solutions. This is the Samsung 980. Nope, there's no Evo or Pro branding here—just 500GBs of pure M.2 PCIe 3.0 performance.

Debuting in 2021, it's a bit of a curious drive. It's based off Samsung's 128-layer TLC V-NAND, and features Samsung's Pablo controller, all on the PCIe 3.0 platform. It also doesn't have a traditional DDR cache, either, but instead uses an SLC buffer cache to amp up the speeds. It's not a huge cache by any means, however, and the controller's not great either. Once the cache is full, performance does tend to fall off a cliff a bit, so if you're looking at transferring large data sets, this might not be the drive for you.

That said, it's still a super-affordable budget PCIe 3.0 drive, capable of delivering up to 3.1 GB/s on sequential reads and 2.6 GB/s on sequential writes, and comes with a 300TBW endurance rating and your standard five-year warranty.

500GB isn't a huge amount, but given we're not exactly expecting our 8600G to be breaking frame-rate records in *COD Warzone* or *World of Warcraft*, the games you're likely to be playing should have smaller file sizes, anyway.

be quiet!
DARK ROCK ELITE

CPU Cooler

Be Quiet! Dark Rock Elite

$100, www.bequiet.com

We are going to preface this by saying that you do not need this cooler for this build. As standard, the Ryzen 5 8600G comes with AMD's Wraith Stealth cooler (the 8700G comes with the Spire). The reason we've included it is that frustratingly, the Ryzen 5 7600X (our subbed dedicated GPU chip of choice) doesn't come with a cooler out of the box. This is mildly annoying, considering it initially launched at an RRP of $300. I mean, yes we get it, it's an X chip—that means overclocking, and to bring your own cooler, but again, it's a budget price, at least chuck in a $20 unit, AMD?

Nonetheless, we've grabbed one heck of an air tower to keep those temperatures under control, no matter what, in the form of be quiet!'s Dark Rock Elite. This chunky unit comes with an intelligent mounting system, RGB, support for Intel and AMD, seven high-performance heat pipes, and twin 135mm Silent Wings PWM fans, as well as an on-board switch, allowing you to swap from quiet to performance mode, depending on your needs. It's big, beefy, and more than enough to keep either of our chips cool under pressure.

V-NAND SSD
SSD 980
NVMe M.2 SSD
500GB
SAMSUNG

RAM

16GB (2x8GB) Kingston Fury Beast DDR5 @ 6000 C36

$76, www.kingston.com

KINGSTON FURY
DDR5
BEAST

For memory, we're actually keeping things quite simple in comparison to some of our other picks. The brief was simple—we know AMD's Infinity Fabric improves performance considerably, and that its operating speed is tied to the clock speed that the memory controller is running at. We also know that both the 8600G and the 7600X are running off a single-core complex, so going above the memory sweet spot for speeds isn't going to give us massive gains on the FPS performance for either chip.

With that in mind, and in an effort to keep pricing low (at the time we priced up this build, we hadn't seen Corsair's Vengeance 32GB kit drop to just $79), we grabbed one of the few 16GB kits that supported our 6000 MT/s requirements at as low a price as possible, and here we are.

This is a bit of a weak spot for the 8600G, and the one area we'd like to improve upon first. Effectively, because the CPU doesn't have the capacity to house additional memory chips on it quite like a dedicated GPU does, your RAM pretty much becomes a substitute for VRAM in this scenario. We'd always recommend you hold on to around 16GB of VRAM, at bare minimum. This ensures any modern system running games and your OS won't run into problems, so having 16GB to act not only as graphics memory, but also system memory, is pushing the limit somewhat, and could rather rapidly become a bottleneck.

If you do intend to build a rig like this, we highly recommend grabbing 32GB of 6000 MT/s RAM instead, especially if it's at the same price, or close to it.

Motherboard

Gigabyte B650M Gaming X AX

$225, www.gigabyte.com

GIGABYTE
B650M GAMING X AX
ARMOR
M.2 SSD

DO IT YOURSELF!
STEP-BY-STEP GUIDE
PG. 22

We knew going into our budget build shenanigans that picking the right motherboard would be key. We didn't need all the overclocking bells and whistles, nor tons of M.2 ports, or a ridiculous amount of on-board I/O with massive RAM overclocking capacity, so instead of opting for an X670 mobo, we decided to grab something a little more low key.

In this case, we picked up Gigabyte's B650M Gaming X AX, and boy is this thing a beauty. It is slightly more expensive than some B650 options out there. In fact, you can find decent boards for around half the price, saving you even more cash if you wanted, but this is well worth the investment.

The rear I/O in particular comes with one HDMI 2.1, two DisplayPort 1.4s, two USB 2.0s, three USB 3.2 Type As, one USB 3.2 Type C, 2.5Gbe Ethernet, WiFi 6E, (somewhat hilariously) a Combo PS/2 port, 8-channel HD Audio, and a QFlash button, too.

Combine that with PCIe 4.0 connectivity (including M.2), and decent support for DRAM, and honestly, this thing is almost better equipped than some far more expensive X670 boards.

Case

Phanteks XT Pro

$50, www.phanteks.com

We knew we needed a budget chassis that wasn't going to break the bank, but had solid airflow, modern build features, decent cooling, and plenty of room to hold all of our components (read: 'seriously big CPU tower').

The beauty of this thing lies in that cooling compatibility, though. You could fit up to nine 120mm fans in it. It's also got support for a 360mm radiator in the roof, a 240mm in the front, or a 120mm rad in the rear, along with plenty of cable management options.

The front panel and roof come in a mesh finish, plus there's a chunky power supply cover. We've picked up the cheapest version of the lot, the Satin Black XT Pro, but you can get a slightly more expensive RGB version instead (the XT Pro Ultra), that's available in black or white.

Interesting fact: it also supports Asus's BTF motherboard 'form-factor', where all the ports on the motherboard are pointing out to the rear of the chassis in the cable management department, rather than out front.

PSU

Corsair CV450 80+ Bronze

$45, www.corsair.com

As this is a budget build, we're going no-holds barred when it comes to saving cash, so have picked up this slightly aging Corsair CV450 PSU. You can find these in the wild from some retailers for around $45 or so, although Amazon and Corsair webstore stock is limited.

If you've got a bit of extra cash spare (literally $5 or $10), we highly recommend picking something up around a similar wattage and price, if you can. Ideally, you'd be better off getting something at the 550W mark or above, such as a Corsair CX650, the EVGA 650BP, or the MSI MAG A650BN, all of which retail for between $55 and $60.

Regardless of your decisions, it's always worth remembering the golden rule when it comes to picking a power supply for your system: always make sure you go with a well-known, respectable manufacturer, and that your PSU comes with a good warranty, both from the store you bought it from and the brand itself.

Otherwise, there's not a huge amount to go over with our CV450. It's an 80+ Bronze unit, has 450W of power delivery, is non-modular, and has just the right amount of 12V EPS and PCIe power connectors that we need to make this build tick.

CORSAIR
CORSAIR
CV450

DEDICATED GPU HARDWARE

Intel GPU

Acer Predator BiFrost OC Arc A750 8GB

$200, www.intel.com

It might come as a shock, but Intel has the high ground on the entry-level GPU battlefield. At just $200, the Intel Arc A750 runs rings around the competition, particularly for those on the hunt for a decent 1080p GPU.

AMD's RX 7600 is $70 more expensive at $270. That's a lot of cash when you're playing around with such a tight budget. In our testing, the 7600 averaged 86fps at 1080p across all our titles, while the Arc A750 manages 74fps—that's a 12fps difference. However, when you compare to that to the contrast in price, you're talking a 26 percent increase in price for only 16 percent more frames per second. That's not bad, considering Intel's Alchemist architecture is its first proper dedicated GPU architecture.

Otherwise, Acer's Predator BiFrost OC card design is interesting. It seems to be a mishmash of both a blower design and a dual-fan setup, with a smidge of RGB built in. It works just fine, keeps the GPU perfectly cool, and delivers some epic clock speeds in the process, but it lacks the certain suave style of its competing AIB partners in the industry. Still, for our needs, it'll do just fine.

CPU

AMD Ryzen 5 7600X

$208, www.amd.com

The reason we've picked this over the 8600G is simple: 16 full-fat PCIe 4.0 lanes. Unfortunately, the 8600G only has the x8, and although that doesn't impact the 7600 XT, Intel's Arc A750 does utilize all 16 of those PCIe 4.0 lanes for its data transfer.

The 7600X comes with six cores, combined with multi-threading for 12 threads, a base clock speed of 4.7 GHz, and a 5.3 GHz max boost clock. AMD's also got 32MB of L3 Cache, managing all this on a 105W TDP and a single core complex.

While you could opt for the Ryzen 5 7600, the major differences come with lower clock speeds, TDP, and slightly worse performance in computational benchmarks.

AMD GPU

Gigabyte Gaming OC RX 7600 XT 16GB

$330, www.amd.com

The RX 7600 XT is a bit weird, for lack of a better word. It's effectively a GPU refresh that's added an extra 8GB onto the base RX 7600, with the caveat that only clock speeds have changed between the two. That's right—the GPU is practically identical to the RX 7600. The only thing that's changed is the TDP going up from 165W to 190W, and the clock speeds up by 100 MHz, which is fairly moot, given most RX 7600 cards are overclocked, anyway.

So, why did we pick it? In our testing, at 4K the 8GB 7600 failed, with a few titles crashing or not completing their benchmark runs due to a lack of VRAM, while the 7600 XT sailed through. That doesn't sound important, particularly as these cards aren't averaging big 4K numbers, but there's one AAA title that monsters GPU VRAM: *Cyberpunk 2077*. At 1080p, the 7600 XT averages around 25fps, while the 7600 manages just 11.

For our 7600 XT, we've gone for the Gigabyte OC variant. It's a triple-fan cooler, and surprisingly efficient, too, at least compared to the Arc A750, so let's see how it does in competition with the plucky blue underdog.

intel ARC A750
RADEON
GIGABYTE
GIGABYTE
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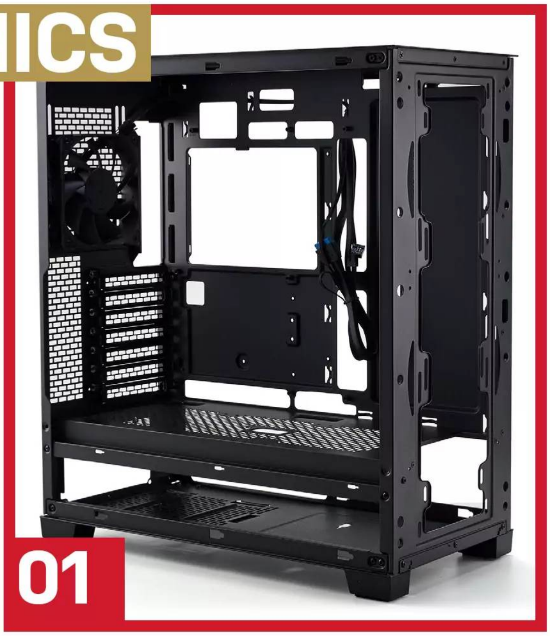
DO IT YOURSELF!
STEP-BY-STEP GUIDE
PG. 22

PRAGMATIC GRAPHICS

be quiet!
PHANTEKS


01

03

LENGTH OF TIME: 1 hour
DIFFICULTY: Easy

BUILDING A BUDGET RIG is always an interesting process. Unlike the glamorous, ridiculously illuminated, fantastical 4K gaming PCs we often tend to make, a budget build brings us back to the roots of what it is to build a PC. Although modern advances have made PC building comparatively easy next to what it was in the simpler times of the early 2000s, the basic premise—the feel of it—is the same. It may not be as complex, as there's no liquid cooling or 200 RGB cables to manage, but there's some excitement around it, nonetheless; anticipation on how it's going to perform.

Budget componentry is far more intriguing at its core. Not only is it, ironically, increasingly challenging to secure the samples for these kinds of builds (no company wants to send out a bronze PSU these days), but seeing how the performance of that Titan, Core i9, or Ryzen 9 makes its way down into the more mainstream and accessible componentry, and how it performs in that scenario, is incredibly interesting. After all, not everyone has $4,000 to spend on a gaming setup. Yet the thing that we all share in common is that passion in our hobby; that desire and excitement around seeing what performance we'll get out of the build that we've spent our hard-earned cash on.

Choosing the right components and making the correct investments, particularly when you don't have a huge amount of spare cash around, is hugely important. That's what we're looking to clear up here. The value of the dollar changes, depending on how much of it you have. Making sure that you're not wasting money on a dedicated GPU when an iGPU will do (answering questions like this is the whole reason *Maximum PC* exists as it does today). So let's dive in, and see whether our builds sink or swim in this sea of dedicated and integrated graphical confusion.

1 Chassis teardown

This is going to be a very granular build log. As we mentioned, budget builds, particularly when they lack a GPU, are far easier to put together. There's not a lot to worry about here. That's great if you're just starting out on your PC-building journey, and of course, you can always add a graphics card later, or a set of fans, or a liquid cooler. That's the beauty of this hobby; the room to tinker is vast in comparison.

As always, we start with the humble chassis strip-down. Our Phanteks XT Pro is a fairly easy thing to tear apart. Pop the front panel off by pulling carefully from the underside of it. The rear panel and glass windows come off with thumbscrews. Likewise, you can also remove the dust filter on the roof (it's magnetic, so simply lifting it off will do the job). There's also a hard drive caddy that has all of the accessories that we'll need for the chassis.

To actually remove the cardboard box with all that in, you have to take off the entire HDD cage. It's a little bit impractical, but nothing to worry about. Underneath the PSU shroud, near the back of the rear panel, you'll find a thumbscrew holding it in place which you can unfasten. You can then remove the cage, and you're all set **STEP 1**. It's actually quite the interesting design, as you can mount two 2.5-inch drives directly on top of it, or just the one, and of course a 3.5-inch

02

05

06

04

underneath it, or on top of it as well. It's impressive what a few screw holes will let you do.

2 Motherboard preparation

Here, we have our pride and joy, Gigabyte's B650M Gaming X AX motherboard, and boy does it look stunning. That armor finish is sublime, and looks even better in person than in photos. It is MicroATX, so a little on the small side, but shouldn't look too out of place in the XT Pro. Take your motherboard out of its box, remove it from its electrostatic bag, and then place it on top of the cardboard box **STEP 2**. Don't place it on the bag, as the outside is conductive, so anything that has an electrical charge in it that touches the bag will run straight into your board. Not cool.

First up, we're going to get that 8600G installed. AMD is utilizing an LGA socket for all of its Ryzen 7000 series chips and above, so if you've ever spent any time around an Intel socket in the last decade or more, you'll be golden here. To install your chip, move the retention arm on the right-hand side out to the right and up out of the socket holder. Once you've done that, you'll be able to move the retention bracket up, revealing the delicate socket and its pins below it.

With the bracket up, take your CPU and carefully align it with the socket itself. You'll see in **STEP 3** that there's a small golden triangle on the top left of the CPU bracket. The CPU itself has one on it as well. That's going to help you align the CPU with the socket. Carefully place the CPU into the socket, slowly dropping it into position. Once it's in securely, give it a little wiggle with your finger to check that it's secure, then reverse the process by repositioning the CPU retention bracket into place, and then the retention arm back under its lock. Once down and secure, the plastic cover will pop off. If it doesn't, you should be able to simply remove it with your fingers.

3 Memory goes in

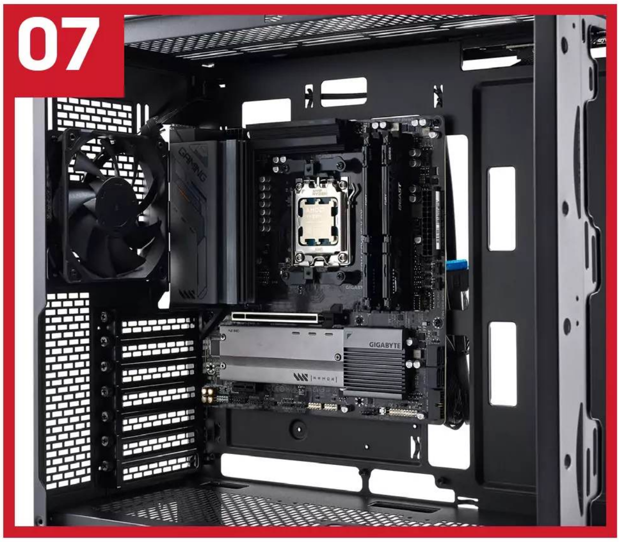
Once the CPU is in, it's onto our DDR5. The B650M Gaming X AX has four slots in total. You want to install your DIMMS in the first slot (closest to the CPU), and the third slot away **STEP 4**. This does two things: it gives us a bit more clearance from the CPU if we're installing any large waterblocks or air coolers, and sets the DRAM up in their respective channels, giving us maximum performance. If you're ever in any doubt, or are using a bit of an odd motherboard, always check the manual. It will tell you exactly which slots you should install your dual channel kit into.

To install the sticks, lift the latch up at the top of the motherboard in the correct slots, line up the notch in the stick with the bump in the board, and carefully push your RAM into position. The latch will click back down into place, and your memory should be flush and level across the length of the slot.

It's important that you get this bit right, as if the memory is incorrectly installed, in the best-case scenario it won't register on the system, and the worst case, your machine won't boot at all. You could spend the next two hours trying to troubleshoot it, panicking that your CPU or motherboard's fried. Always double-check your RAM.

4 A single SSD

Next on the to-do list is our M.2 SSD. Our M.2 slot is hidden away under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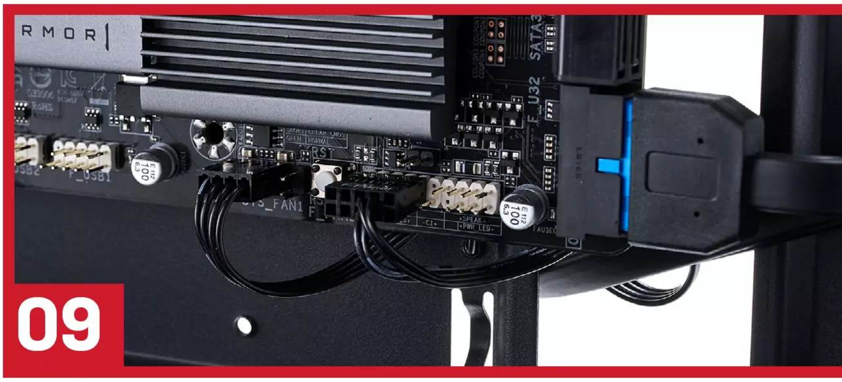
GAMING
AMD RYZEN

08

CV450
CORSAIR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that small armor plate located below the topmost PCIe slot. To remove it, grab a trusty Philips head screwdriver, and unfasten the three screws on the plate. They're retainable, so you don't need to remove them all the way. With them loosened, you can then lift up the armor plate, revealing the M.2 slots underneath.

Although it doesn't matter in this case, you almost always want to use the topmost slot for your OS SSD (or fastest drive). The closer it is to the CPU, typically the higher-spec the M.2 slot will be, usually taking advantage of direct PCIe lanes rather than going via the chipset. Also, although fairly unproven in today's age, there is some argument that the closer the M.2 is to the CPU, the less distance data has to travel over motherboard traces, which improves latency, albeit incredibly marginally.

To install your M.2 SSD, lift up the tab on the far left of the M.2 slot near the CMOS battery, then carefully slide your M.2 SSD into position. There's a notch cutout in the drive, similar to the RAM we installed earlier, and a notch on the M.2 slot itself as well, ensuring you can only install it one way. However, a good rule of thumb to remember is that the branding logo will almost always be facing upward. Once in, push it into position. It'll likely pop up a little bit at an angle—that's normal. Push it down, and secure it in place with the latch we released earlier **STEP 5**, then resecure the armor heatsink we removed earlier, making sure to remove any plastic film from the thermal pad underneath.

5 Shhhh!

It's time to get be quiet!'s mounting points installed. When it comes to AMD chips, the motherboards always come with a fairly hefty stock backplate, so you won't have to worry about needing one with the cooler. In our case, we've removed the bottom plastic bracket that comes with the motherboard and replaced it with the ones provided by be quiet!, ensuring that the angle on the bracket itself is facing the correct direction. There are small plastic spacers that also need putting into position on top of the backplate before the bracket is added and screwed back into position **STEP 6**.

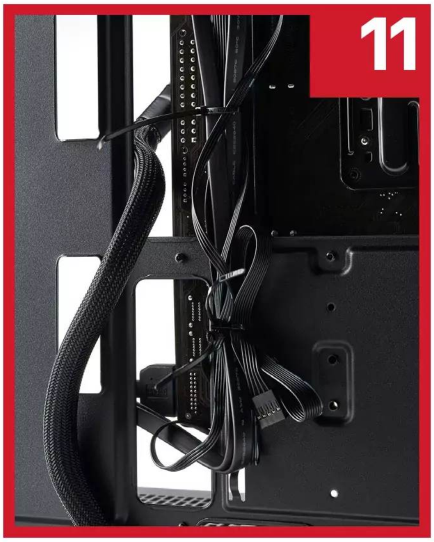
With the last of our prep work done, it's time to get our B650M into the chassis. Lay the case down on its side so you've got good access to the interior, then carefully place your fully prepped motherboard into the build. Align the rear I/O with the cutout and place it so it sits above the included stand-offs in the chassis itself.

Once the motherboard is correctly aligned, you can then proceed to secure it with the correct screws. The case will typically come with a manual telling you what screws you need to use—in the XT Ultra's case, that's its SSD + Mainboard screws (there's 30 of them in the kit, so you'll have plenty). Make sure you secure them correctly, and that there's plenty of them, as they'll help earth the motherboard to the chassis.

Once you've successfully secured all the screws, you can flip the case back onto its feet again to admire your handiwork **STEP 7**.

6 Supplying that power

Okay, so the motherboard's in, and we've not got a GPU to manage, or any fancy cooling solutions to worry about. Next up is the power supply. As this is a non-modular unit, there are a few things we can do to make this process go a little smoother. First up, we're going to slide the entire unit into the case from the



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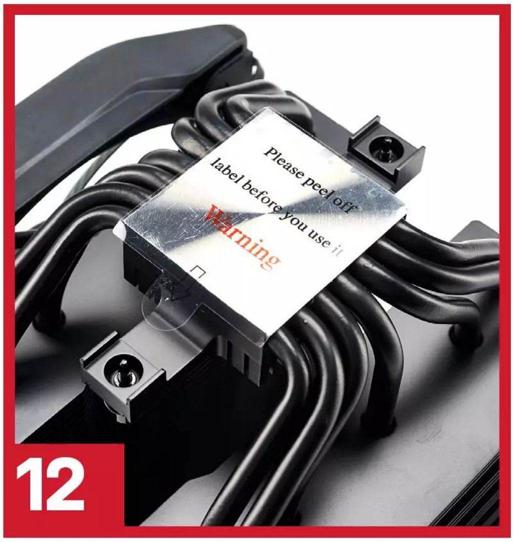

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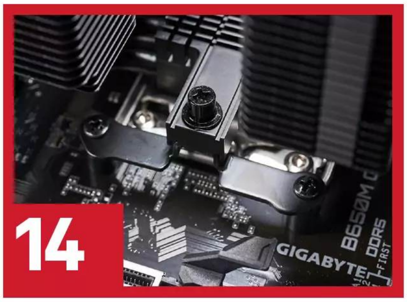

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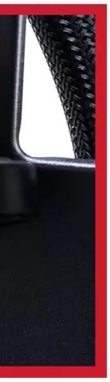

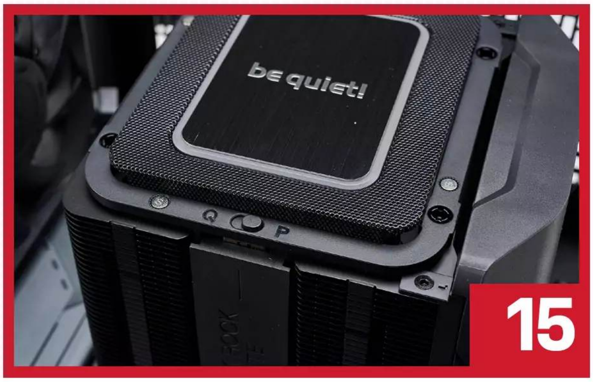

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GIGABYTE
ARMOR

16

rear. We've decided to opt for the fan to be facing up and into the chassis itself. Because we've got a limited number of fans in this build, adding this as an extra exhaust is going to help. If you do have more fans and are controlling your airflow more efficiently, it's often better to isolate the power supply entirely, and have the intake fan facing down, drawing cool air through the floor if the case supports it.

Anyway, once it's slid in, secure with the included screws, then get to work organizing your cables **STEP 8**. For this build, you're going to want a single 8-pin EPS cable for your CPU power, located on the top left of the motherboard **STEP 10**, a 24-pin ATX power to go into the right-hand side of the motherboard, and, er, that's it. Run these through the correct cable holes, install them into the motherboard, and you'll be good to move on to the next step. If you're going down the dedicated GPU route, you're going to need PCIe power, too. In our case, we're pre-threading ours just underneath the cutout, ready to swap out later. With the rest of them, bunch them together, strap a few cable ties around them, then wedge them under the PSU shroud. Job done.

Next up are the few cables we have to install. Your power switch and LEDs are going to be handled by a block connector Phanteks has built into the XT—locate the correct headers on the motherboard, and slide that into position. You can also connect your fan to a system fan header (in our case, Sys Fan1).

Lastly, the USB 3.0 cable for our front I/O ports can be plugged into the header on the board as well. You can be a bit sneaky and actually tuck some of these through a grommet, around a motherboard standoff, and up into position to keep them tidy in a build where you're not taking advantage of all the space. It saves them from looking a little out of place, trailing all over your rig **STEP 9**.

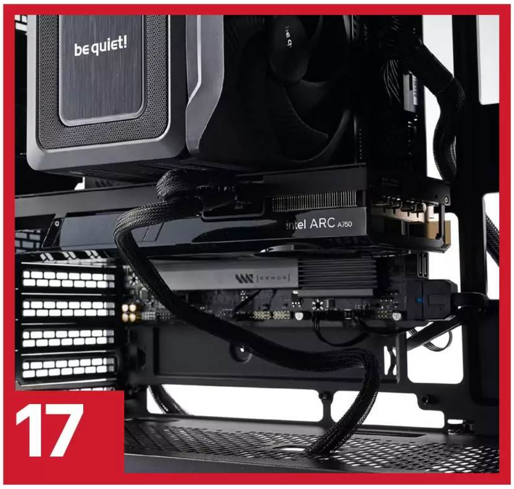
As for any unused cables, like our PSU cables, bunch them together and cable tie them where you can. We've grabbed the HD Audio header and tied it up onto the back of the motherboard tray **STEP 11**.

7 Elite cooling

We're almost finished—now, it's time for our CPU cooler to get installed, and we'll be completely wrapped up. The be quiet! Dark Rock Elite is a pretty stellar cooler design. The central fan is held in place with rubber push pins, and on top of that, you'll find the RGB be quiet! plate logo, as well as the performance/quiet mode switch. Pull this out to get the cooler ready for installation.

Then, you're going to want to flip the cooler over and make sure you remove the plastic film **STEP 12/13** from the tower. The last thing you want is to leave this on and impede the cooling going to your chip. Once that's done, place a dollop of thermal paste in the middle of your CPU—think a piece of sweetcorn, and you're on the right track. Then, position the cooler on top with the front-facing fan looking toward the front of the case. Once in, and the screws in the middle are positioned over the mounting holes, secure it into position by screwing each side a little bit at a time until you reach the end of the thread **STEP 14**.

Once done, find the front fan, and grab the cable attached to it. You'll notice that it's a small form factor proprietary connector. Locate your middle fan, and you'll find a daisy chain attachment here. Connect the two together, then slide the middle fan in until it clicks into position



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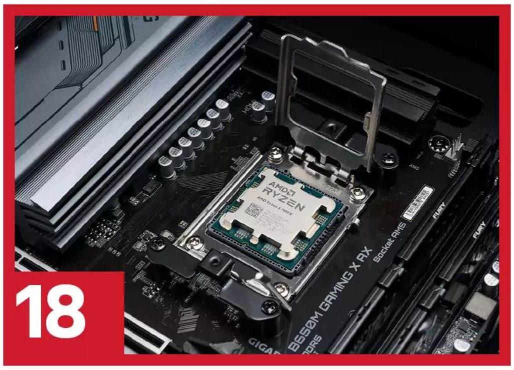

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STEP 15. Then, run the single PWM fan cable to the CPU fan header on the top of the board. Once complete, you can install your ARGB cable into the header as well. The B650M is a little tricky for ARGB headers, and the cable on the Dark Rock Elite implies that you need to install it in the top right header, which is mildly inconvenient, as the Gigabyte board doesn't have a header there. We've weaved ours underneath the M.2 heatsink and down to the connector at the bottom of the board near the USB ports **STEP 16**.

After all that, select your fan speed mode on top (Q for quiet, P for performance), then attach the magnetized top cover back into position, and you're done.

GPU LEAGUES, THE STOREY CUT

SO THAT'S effectively the bread and butter for building your own iGPU PC, but what about if you wanted to go with a dedicated graphics card instead? We've got you covered there too with a few more minor steps.

Replacing the CPU

With our iGPU build photographed, we decided to go through the process of changing the CPU and GPU out to show you just how easy it is. Deconstructing PCs is a time-honored tradition, necessary for diagnosing and replacing hardware, so it's a good skill to have.

In our case, given that the build is surprisingly easy to work with, it's not all that bad—all we have to is swap out that CPU. To do that, we're going to remove the fan cables connecting to the CPU fan header, and that ARGB cable we painstakingly installed underneath that M.2 heatsink earlier. Then, remove the middle fan on the Dark Rock Elite, pulling upward, before finally releasing the CPU tower from its mount.

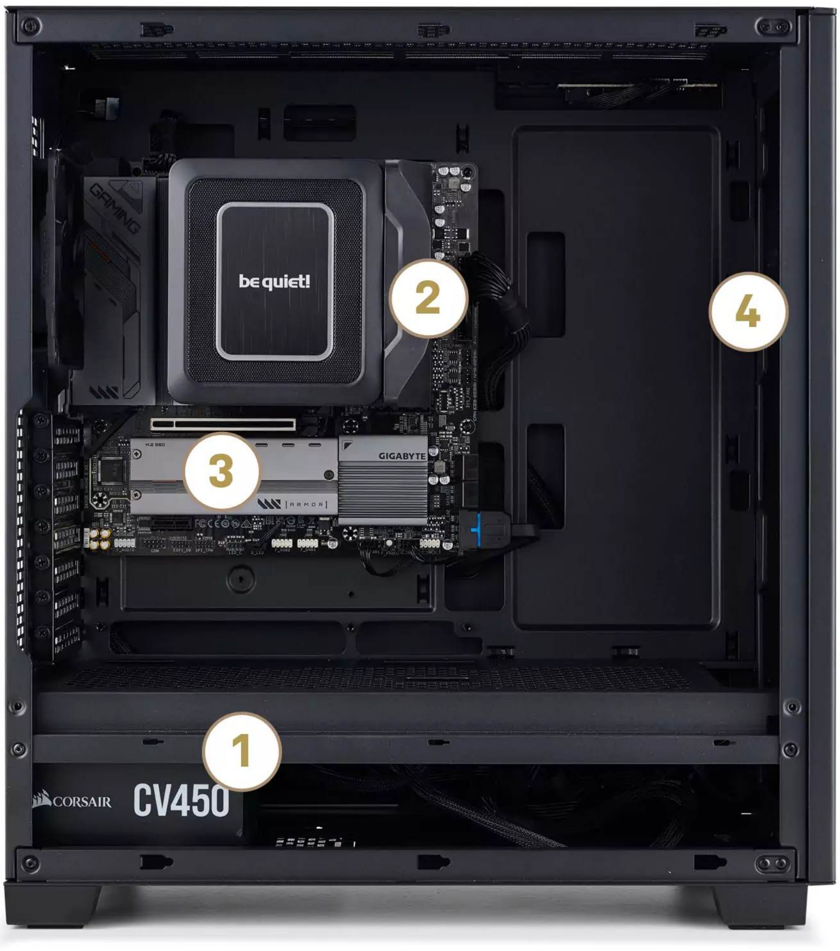
At this point, to avoid getting thermal paste everywhere, grab a microfiber cloth—or some kitchen or toilet roll, in a pinch—and some isopropyl alcohol, and give that CPU a good clean. Don't forget the bottom of the CPU tower as well.

Fun fact: isopropyl alcohol doesn't have a lower boiling point than water; the space between its molecules is slightly larger than with water molecules, meaning that it evaporates faster. Regardless, this means that thanks to that fast action, it's perfect for cleaning off thermal paste from CPUs.

Once the CPU is clean, lift up the retention arm and remove the bracket once more. Then, carefully grab the sides of the integrated heat spreader on the CPU and lift it out, being careful not to twist or torsion it in the socket. It's easy to damage the CPU socket here, so you do need to be careful—one wrong drop, and your socket might be irreparably damaged. With that done, it's then a case of following on from what we did earlier, placing the Ryzen 5 7600X in its place **STEP 18**, then carefully reinstalling the CPU tower.

At last, the GPU

With our new CPU in place, carefully lower the chassis onto its back, and prepare it for that GPU. Remove the two PCIe slot covers on the rear of the case, closest to the PCIe slot we'll be using (you may need to take out more if you have a larger card). Keep the screws handy, as you'll be using those to secure the GPU back down. Then, slide your graphics card into position until it clicks into place. Secure it with those screws, and install the final power connectors (we kept ours tucked away underneath the PSU shroud for just such an occasion), and you're golden **STEP 17**.



1 The power supply down here really is scraping the barrel a bit, and is a slight regret on our part. Opt for a 550W or 650W variant instead, and you'll be far better off for just $5-10 extra investment.

2 Likewise, our memory choice could do with a serious upgrade, although you can't see it to the right of the CPU tower. Corsair's Vengeance kit in our Blueprints budget build this issue is $79 for 32GB of 6000 MT/s memory.

3 Although the Samsung 980 M.2 SSD under the heatsink is a budget solution, and a pretty potent one, getting a decent PCIe 4.0 drive instead would help with day-to-day operations and drive speed.

4 Three fans in the front would help keep temperatures down to a more reasonable level. They don't need to be fancy; preferably something you can daisy-chain together would be ideal.

BACK TO THE BASICS

SOMETIMES, going back to square one doesn't help. Building advanced 4K gaming PCs and liquid-cooled machines is nice, but perfecting the bread and butter of creating your own budget PC makes for a nice change of pace. It's useful, as it actually does present some challenges that you wouldn't otherwise come across.

Take our ARGB header for the CPU cooler. Any other motherboard would have an ARGB header at the top right. This one doesn't, so how do you work around that with a short cable? The MicroATX form factor doesn't take up a ton of space in the Phanteks XT, so how do we cable-tidy it effectively without trailing cables all over the place? The cooling we have available is effectively two fans, and one of those is the power supply, so what's the best way to get the perfect system temperatures with what we've got? They're not particularly fiddly problems, but doing more with less certainly helps to give the brain a little challenge. In a more extreme build, most of your cooling is handled by RGB controllers, and fans by fan controllers. ATX boards would fit in an ATX case, and you'd probably have enough fans to start a Patreon project.

Speaking of the Phanteks XT, although incredibly affordable, it didn't disappoint. For the money, you get some serious style, with plenty of airflow and awesome cooling support. Corners have been cut in places, some of the panels are an absolute pain to slide into position, and the cable-management solutions could be better, but honestly, for the price, it's nearly perfect. However, the XT Ultra may be a better bet, if only because you get those three additional fans to act as an intake. It's one of the few areas we'd dramatically like to tweak compared to what we've actually done here.

Given the price limitations, there's very little else we'd change from a build perspective. All in all, it's an incredibly tidy build, helped in no small part by a serious lack of cables and additional components, and even with the GPU, that's only one extra power cable added. You could go even more nuclear, and not plug in the USB 3.0 header for an even cleaner look. It's also a build that could do with a touch of lighting—maybe one of those 12-inch white LED strips we're so fond of.

Interestingly, after building and testing this PC, we can safely say that there are a few hardware changes we'd make if we could that would save some serious cash. Dropping to a Ryzen 5 7600 CPU for our dedicated GPU build would reduce the price by $30, and get us a Wraith cooler instead of the Dark Rock Elite. That would be a $130 saving. Likewise, if we hadn't needed a level playing field, removing the Elite from the 8600G variant would also save an additional $100, bringing those two prices down further. That would make the dedicated build $841, compared to $691 for the integrated build. Not quite PS5 territory, but actually not that far off.

8600G vs ARC A750 vs RX 7600 XT

A complete top-down analysis of the 8600G

WE WENT INTO THIS BUILD with one simple goal: to ascertain whether AMD's Ryzen 5 8600G was capable of gaming at 1080p, and doing it well. Plus, with that caveat attached, whether it was better value than a dedicated GPU solution instead. After all, modern-day graphics cards are expensive, and even the cheapest value option out there right now—Intel's Arc A750—still clocks in at a fairly hefty $200. Building a budget gaming PC is hard work, particularly when you can pick up a PS5 or Xbox Series X for just shy of $500. Both of these are capable of providing a pretty decent gaming experience at 4K.

With that in mind, unlike our traditional builds, this system has undergone some seriously hardcore testing. There are no less than 80 benchmark runs here across a wide variety of configurations, which should hopefully answer that question, at least for now. Is budget PC gaming dead? Let's dive in.

Computational results

To recap, we effectively have three different builds on the chopping block today. Our first setup is our cheapest entry-level build, featuring the Ryzen 5 8600G running solo on its own, complete with 16GB of DDR5 @ 6000 MT/s, and coming in at around $791. Our second combo houses an AMD Ryzen 5 7600X and Intel's Arc A750 graphics card for just shy of $971. Our final configuration is a slightly more expensive version of that, but instead of running that A750 GPU, we've gone with the 16GB Radeon RX 7600 XT. That last build gives us slightly more dedicated VRAM, and a better GPU, but it does come in at $1,101.

As you can see from our computational tables, the 8600G on its own with 16GB of DDR5 performs pretty admirably across most of our testing. In CineBench, the 8600G's multi-core performance actually outshone the Ryzen 5 7600X by a small margin, despite the fact that the single-core performance was lower comparatively. Dive into GeekBench 6.2.1, and you'll see similar results there, too. However, the 8600G's multi-core performance didn't quite achieve the same heady heights as it did in CineBench.

Unsurprisingly, Blender took full advantage of those dedicated GPUs in the other two configurations and mopped the floor with the 8600G's integrated graphics. Interestingly, the much cheaper Arc A750 actually outperformed AMD's RX 7600 XT quite significantly in Scene 1 and Scene 3, and only lost by 20 points in Scene 2.

Continuing on to our SSD performance, surprisingly, the 8600G struggled to eke out the same metrics as the Ryzen 5 7600X. It lagged behind by 70 MB/s on the Random 4K Write speeds, and by 10 MB/s

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COMPUTATIONAL TESTS	AMD Ryzen 5 8600G	AMD Ryzen 5 7600X + Intel Arc A750	AMD Ryzen 5 7600X + AMD Radeon RX 7600 XT
CineBench R23 Single Core (Index)	1,775	1,917	**1,922**
CineBench R23 Multi Core (Index)	**13,256**	13,096	13,095
GeekBench 6.2.1 - Single (Index)	2,540	2,883	**2,890**
GeekBench 6.2.1 - Multi (Index)	9,412	11,646	**11,727**
Blender (Index)	80 / 55 / 42	**1040** / 349 / **561**	641 / **359** / 333
Crystal Disk QD32 Seq Read / Write (MB/s)	3,170 / 2,312	3,166 / 2,248	**3,175** / **2,328**
Crystal Disk Random 4K Read / Write (MB/s)	56.91 / 153.97	64.89 / **221.88**	**65.43** / 221.38
Max CPU Package Temp	85.1 C	88.5 C	**83.4 C**
Max GPU Temp	--	75.0 C	**60.9 C**

Best scores are in bold. Test bed consists of a Gigabyte B650M Gaming X AX motherboard, Corsair CX450W PSU, 16GB (2x8GB) of Kingston Fury Beast DDR5 @ 6000, and a Samsung 980 M.2 PCIe 3.0 SSD.

on the read test too, although sequentials remained competitive.

Temperatures were fairly consistent across all three setups (perhaps unsurprisingly, given the cooling we'd chosen), with the Ryzen 5 7600X clocking in 83.4-88.5 C in the two dedicated GPU builds, and the 8600G landing right in the middle of those two at 85.1 C.

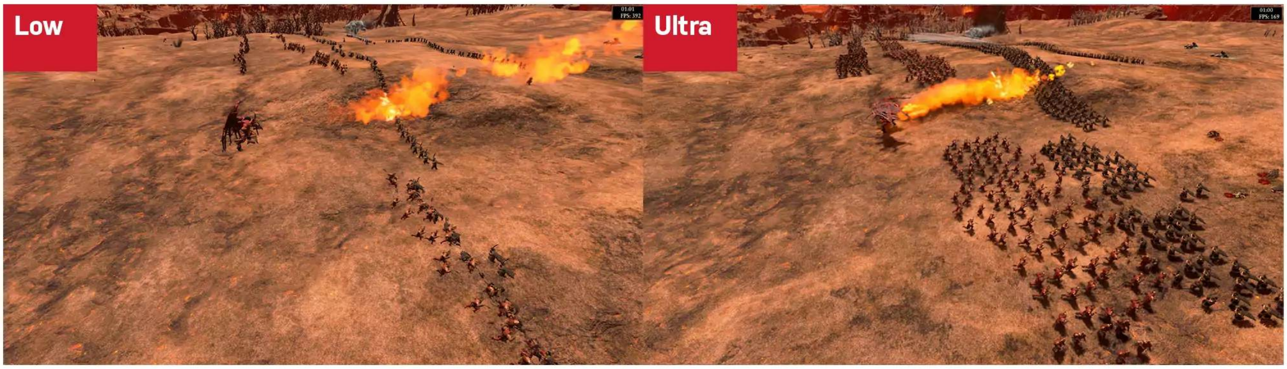
Gaming Results

Let's face it, though—those computational tasks are just one piece of the puzzle. The real prize lies in the gaming department. Across our three setups, we actually saw some incredibly interesting results off the back of our 80 benchmark runs.

We decided to test a total of eight games at 1080p, using the second highest graphical preset in each title as standard. Where possible, we did enable AMD's FSR 2.0, or Intel's XeSS upscaling, depending on which one gave us the better performance boost. Additionally, *Shadow of the Tomb Raider* was configured to operate with the DX11 API, not DX12.

There are also a few cells in the table that are going to be marked as Red, particularly for the 16GB Ryzen 5 8600G tests. This means either the game auto-adjusted its settings so it was compatible with the CPU, and would actually run (bypassing our high preset rule), or that it didn't complete the run at all.

So what are the takeaways from this round of testing? Well, at 1080p with 16GB of RAM, the Ryzen 5 8600G struggles to put in any semblance of a performance against the other two card combos. The tests it did complete landed well below the 20fps mark, and everything else had altered presets or wouldn't even load. The synthetic 3D Mark scores also show some serious degradation compared to our other results. That's a shame,



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The difference between Low and Ultra in *Total War: Warhammer 3* is staggering.

at a guess, this is down to that limited DDR capacity. Throughout testing, we monitored the system load using Task Manager and HWMonitor, and MAX would repeatedly max out, drastically dropping performance across the entire rig.

It seems that AMD's APUs are very dependent on both memory bandwidth and capacity for graphical performance, as it lacks the independent VRAM found on dedicated GPUs. If you don't have enough to simultaneously run the OS, and provide a big enough buffer for gaming, you're going to have a bad time even at 1080p.

Battle of the GPUs

Out of our two graphics card combos, we actually got some intriguing results. Again, you do have to bear in mind that these games were tested on the High preset, not Ultra, and at 1080p, the Arc A750 averaged 115.29fps across all eight titles, and the 7600 XT landed at 139—not too shabby at all. Whether that 24fps boost is going to be enough to justify the extra $130 cost is going to be down to the size of your pockets, however.

Theoretically speaking, the 16GB RX 7600 XT is the 'better value' GPU. Dollars per frame round out at just $7.93 for the entire system, while the Arc A750 managed $8.42, despite the overall system cost coming in lower.

Both are good picks when it comes to 1080p gaming, that's for sure. Still, Intel has the advantage when it comes to rendering-based tasks, that much is clear. It's worth mentioning, though, that both the Arc A750's power draw and temperatures are significantly higher than the 7600 XT's, and that 8GB of VRAM might not be enough later down the line.

Head to head, Intel vs AMD, GPU vs GPU.

Sometimes, you just need a bigger and faster memory kit to make an APU tick.

AMD Ryzen 5 8600G @ 32GB

Because we kept hitting that 16GB DDR5 cap consistently with our 8600G, we expanded our test suite after we'd initially finished, and ran an additional set of benchmarks for the 8600G, this time with 32GB of DDR5 @ 6400. The aim was to see just how much that extra capacity and additional bandwidth affected overall performance, and oh boy was it a doozie.

Pretty much every single title we had in our test suite completed its benchmark run successfully, the only exception being *Red Dead Redemption II*. Sadly, it still adjusted its profile down to 'low', despite being set to 'favor quality'. Nonetheless, the vast majority of games clocked in at around the 30+fps mark, making this a surprisingly comfortable 1080p gaming solution, if you can back it up with 32GB of DRAM at a similar price (which we now know you can, if it's on offer).

That's far better than our 16GB attempt from earlier. In fact, taking a quick glance at the results, it's quite surprising just how well it did in *Final Fantasy XIV*, clocking in a smooth 38fps on its own, making it a bit of a beast for small form factor esports and MMO titles.

Let's be clear, though: it still has an average frame rate across those eight titles of just 35. When you factor that in with the cost of the build, you're effectively looking at $22.69 per frame generated, making it nearly three times less cost-effective than the RX 7600 XT solution.

The conclusion?

Firstly, AMD's Ryzen 5 8600G is a curious thing. At its heart, it's a fairly well-balanced six-core processor, particularly suited to entry-level computational work. If you want, you could theoretically pair it with a dedicated GPU later down the line. However, because of that 8x PCIe 4.0 GPU lane limitation, opting for any heavy-duty graphics card would throttle its performance and be a waste of money.

That said, with plenty of memory support, you can get relatively decent performance. If gaming at 1080p is your aim (and to a lesser extent 1440p as well) either of our two dedicated GPU solutions still provides a far better platform and performance. You would, of course, be better off getting the 7600 XT from a pure value perspective, but if you can't stretch that far, then something like the Arc A750 will work a treat in that you'll struggle to tell the difference, certainly on the High preset.

Sadly, however, the elephant in the room remains true. If all you care about is gaming, then consoles provide a far better experience for far less initial outlay. Both the PS5 and Xbox Series X can produce decent frame rates at 4K. Heck, with something like PlayStation Plus or Xbox Game Pass, games have also become fairly affordable on the platforms.

The 8600G is perfect for small form factor, esports gaming, or those looking for a media PC that can handle the odd lightweight title. But if you want anything like serious performance, you need to go dedicated. Sadly, that's still just a fact.

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1080P GAME TESTS	AMD Ryzen 5 8600G 16GB RAM	AMD Ryzen 5 8600G 32GB RAM	AMD Ryzen 5 7600X + Intel Arc A750	AMD Ryzen 5 7600X + AMD Radeon RX 7600 XT
Total War: Three Kingdoms (avg fps)	DNC	34	110	**134**
Final Fantasy XIV (avg fps)	16	38	146	**155**
Cyberpunk 2077 (avg fps)	14	24	97	**113**
Red Dead Redemption II (avg fps)	20.5	37	93	**103**
Total War: Warhammer III (avg fps)	11	28	86	**106**
Shadow of the Tomb Raider (avg fps)	13	33	75	**121**
Metro Exodus Enhanced Edition (avg fps)	DNC	16	95	**105**
F1 2022 (avg fps)	DNC	70	220	**274**
3D Mark: Firestrike (Index)	3,333	6,674	27,568	**28,136**
3D Mark: Port Royal (Index)	550	1,439	**6,483**	5,936
3D Mark: Speedway (Index)	160	435	**2,346**	2,075
Average FPS across 8 Games (fps)	14.9	35	115	**139**
Cost per FPS ($)	US$53.09	US$22.69	US$8.42	**US$7.93**
Total Cost ($)	US$791	US$794	US$971	US$1,101

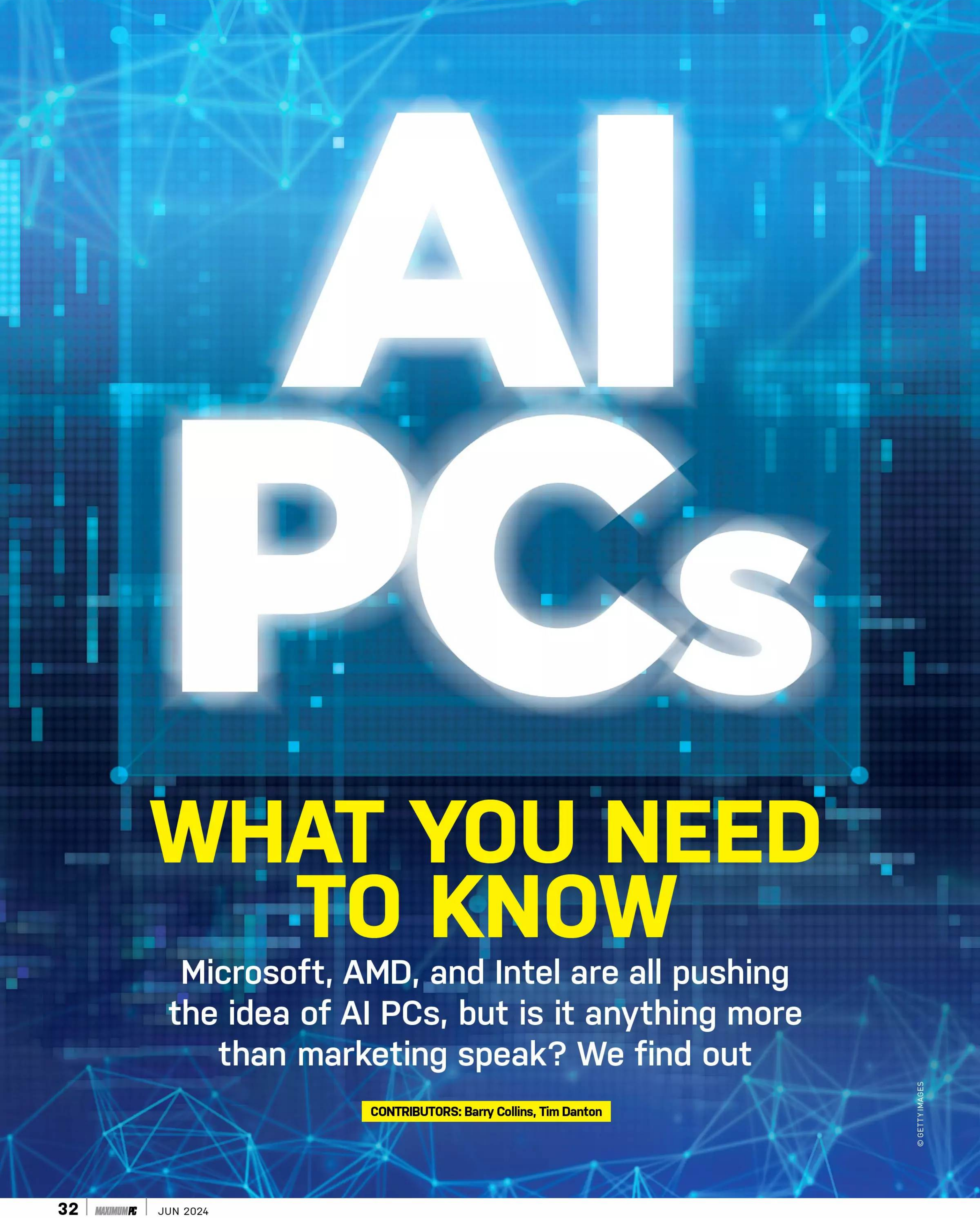
All games were tested at 1080p on the 'High' graphical preset (or 'favor' quality in RDR2). Best scores in bold. Red denotes failed run. Ray tracing disabled throughout testing, FSR 2.0 or Intel XeSS upscaling utilized wherever possible.

WHY ARE CONSOLES SO MUCH MORE EFFICIENT?

It ultimately comes down to a combination of reasons. Unlike the PC, a game developer doesn't have to think about 100 different hardware configurations for their game when they optimize it. The hardware in a PS5, outside of expandable storage, is identical across the board. The same goes for the Xbox Series X. That makes it far easier to optimize their games around it, and really dial in the settings to hit whatever resolution and frame rate they want to.

Secondly, there's the matter of buying components in bulk. You see this to a lesser extent with System Integrators and bespoke PC builders across the planet. Because Corsair, Origin, and CyberPower buy their GPUs in pallets, not individual units, the unit price drops accordingly. This allows them to reduce the price of the overall PC, undercutting the end user at home, buying individual parts. With consoles, that concept is multiplied by a huge mangitude, so they get bigger discounts on the bulk buys as a result.

Lastly, and perhaps rather unsurprisingly for anyone who's gamed on one of the latest-gen consoles, the graphical fidelity just isn't quite as good as it is on a PC. It's close, don't get us wrong, but devs enable and derestrict more graphics options on gaming rigs than on consoles. After all, you can make some incredible-looking games when no holds are barred. ⏻



AI PCs

WHAT YOU NEED TO KNOW

Microsoft, AMD, and Intel are all pushing the idea of AI PCs, but is it anything more than marketing speak? We find out

CONTRIBUTORS: Barry Collins, Tim Danton

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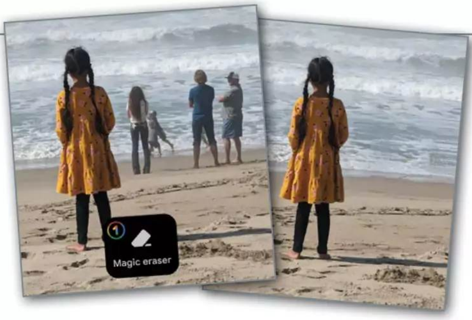


Google's Magic Eraser is AI on your phone, and it's available right now.

REMEMBER WHEN 3D SCREENS were the next big thing? What about virtual reality? Or 5G? The truth is that the technology industry loves buzzwords almost as much as it loves the tech itself, and its latest crush is AI PCs.

But if you ask five different vendors what an AI PC is, you'll get five different answers. AMD and Intel will explain that it's all about their new silicon, which now includes neural processing units. Nvidia will point to its hugely powerful RTX GPUs, while Microsoft will tout its mix of remote and local platforms.

By some definitions, you already have an AI PC to hand via the mobile phone in your pocket. It's personal, it computes, and if it's a recent Apple, Google, or Samsung phone, then it includes plenty of AI-enhanced features. Magic Eraser is one obvious example.

So let's lay down a simple working definition. An AI PC—for the duration of these six pages, at least—is a laptop or desktop PC that includes a processor with a neural processing unit (NPU). That means an Intel Core Ultra, any AMD Ryzen processor with Ryzen AI built in, and Apple MacBooks and Mac desktops with an M1, M2, or M3 series chip.

With that settled, what's the point of an AI PC? What can it actually do? What options are available? And, the fundamental question, should you buy one?

WHAT CAN AN AI PC DO NOW?

IF YOU'RE IN the market for a new PC and are weighing up whether to invest in a so-called AI PC, you might reasonably wonder what advantages it will bring over an 'ordinary' PC.

We'll come to the benefits afforded by the hardware that pretty much defines an AI PC—the neural processing unit or NPU—shortly, but there's another distinguishing piece of hardware found on many AI PCs: the Copilot key.

This was billed as the first major change to PC keyboard layouts in almost 30 years, replacing the menu key to the right-hand side of the spacebar. It's basically a shortcut for opening the Copilot assistant in Windows 11, sparing you the enormous effort of using the current Windows+C shortcut.

"We're excited about having this key on our systems," said Kevin Terwilliger, vice president and general manager of Dell's Latitude and docking business, on a recent AI webinar.

While enthusiasm levels among *Maximum PC*'s professional readership might be more muted, it's worth remembering that 99 percent of users are familiar with only the most basic keyboard shortcuts, and that such initiatives—while seeming cosmetic and trivial—could make a difference.

"We really think of Copilot as the new search," said Terwilliger. "And people are going to be interacting with Copilot throughout their day, engaging with it, asking questions, working with it to create content. And so we think the fact that having that key on the keyboard to jump-start access into Copilot will be very valuable for the end user."

Microsoft is driving Copilot integration deeper into the operating system, too. At the time of writing, Copilot's ability to control the PC is limited. It can help you flick into dark mode, take a screenshot, and open File Explorer, but it's superficial stuff.

However, Windows Insider releases launched at the time of writing show Microsoft continuing to build out Copilot's system-level capabilities, allowing Copilot to show available Wi-Fi networks, clean storage, show which apps are set to run on startup and more.

Again, enthusiasts and IT pros will barely raise an eyebrow, not needing Copilot's help to perform such tasks. But it could (and we stress 'could') make a big impact with mainstream users who aren't as familiar with the workings of Windows. If it spares IT departments from dealing with these more low-level queries, allowing more time to focus on the business-changing stuff, that can't be a bad thing, surely?

The Copilot key can be found on most AI PC laptops, including this Dell Latitude 9450.

Moving on, the NPU is the core component of an AI PC, the factor that really sets it apart from a PC with only CPU and GPU units to call upon. Over time, it's likely that all PCs will ship with an NPU, but for now, they are the key differentiating factor.

But if you're an early adopter, one who rushed out to buy a laptop or PC with an NPU-blessed Intel Core Ultra or AMD Ryzen chip inside, what benefits will you feel right now? Even PC manufacturers quietly concede that the advantages are slim pickings at the moment.

One that crops up in PC manufacturer demos is the NPU's ability to blur the background on video calls. Most users won't care if it's the CPU, GPU, or NPU that performs background blurring, but it can make a difference to power consumption.

Dell ran a demo showing background blur on a Zoom call on an ordinary PC, where CPU utilization shot up to more than eight percent when it was applied. With the same effect locally on the NPU, using Windows Studio Effects, the CPU was barely troubled at one percent utilization.

"This actually translates into a 38 percent power improvement when you're doing these Zoom calls," claimed Terwilliger. "So collaboration is a great area where we'll take advantage of the NPU to deliver energy efficiency and much longer battery life."

That's fine, but it's hard to believe anyone's going to buy a new laptop to save a slice of battery life when

© DELL, GOOGLE

The NPU can be used to blur the background in video calls.

using background blur on battery power. Is anything more substantial on offer?

Dell points to security benefits, claiming the NPU is better placed to deal with threat detection. The firm ran a demo of an unnamed security package, but instead of performing threat detection in the cloud, it used a local engine on the NPU. Dell claims the threat detection on the AI PC kicked in within 20 milliseconds—a 70 percent improvement in latency compared to the cloud.

"Our goal is to not talk about the hype of AI, but show examples just like this to our customers so that they can understand the value of the NPU," said Terwilliger.

You're not racing off to the Dell website to order an AI PC yet? Maybe a more creative application will convince you, and here the benefits are more substantial. Instead of relying on expensive cloud services such as OpenAI's DALL-E or Midjourney to generate images, you could install open-source models such as Stable Diffusion and run them locally instead. You can, of course, do that already on a PC without a NPU, but Charlie Walker, Dell's senior director and GM for Precision workstations, claims it's much faster with the NPU involved.

"If I tried to run Stable Diffusion on my CPU, previously it would have taken two to three minutes [to generate an image]," he said. "Now with the NPU, by offloading that from the CPU into that more efficient architecture... you can do that now in 30 to 50 seconds. So again, significant savings."

The downside? That only more technical users will feel comfortable downloading open-source projects such as Stable Diffusion, despite many in-depth guides online. For local AI to break through, it needs to be simple.

WHAT WILL AI PCS DO IN THE FUTURE?

THERE ARE BENEFITS to owning an AI PC now, but those range somewhere between niche and slight. However, there's almost universal industry agreement that those benefits will rapidly increase well within the lifetime of the average PC.

"What you're doing on an AI PC in 2024 is going to be radically different to 2026," said Intel's executive vice president for client computing, Michelle Johnston Holthaus, at CES in January, a sentiment with which the company's chief rival agreed. "It will probably be the end of 2025 before you really start to see what an AI PC is capable of," said AMD's senior processor technical marketing manager, Donny Woligroski.

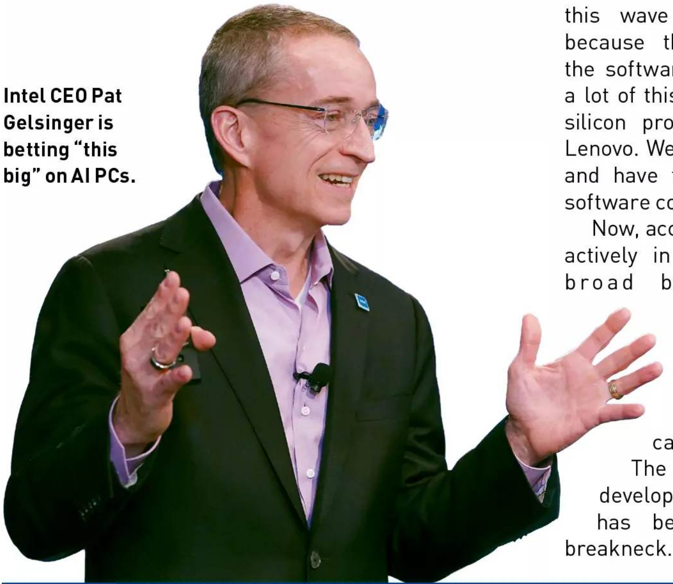
"The GPU is currently the fastest AI processing unit," Woligroski added. "You're going to see that performance cross over, with the NPU doing the same levels of [AI] performance as the GPU."

Lenovo agrees that the best is yet to come from AI PCs, pointing out that the software developers have only just started working with production hardware. "It's almost a chicken and the egg," said Tom Butler, the company's executive director of commercial portfolio and product management. "I've got to have hardware out there that can catch the software benefits."

He added, "The front end of this wave is hardware driven, because there was nothing for the software to write to, because a lot of this was in the labs of the silicon providers and OEMs like Lenovo. We couldn't go out broadly and have these discussions with software companies."

Now, according to Butler, "We're actively in conversations with a broad breadth of software companies. We are, the silicon providers are, basically everybody's looking at this new space to see, 'What can I do now?'"

The pace of product development in the AI industry has been nothing short of breakneck. Subscribe to the



Intel CEO Pat Gelsinger is betting "this big" on AI PCs.

WILL ALL PCS BE AI PCS?

Far be it from us to suggest that the label 'AI PC' has been confected to drive PC sales, but that noise you can hear is the sound of PC sales managers rubbing their hands in glee.

Is the AI PC label likely to be around for long? Will manufacturers sell ranges of AI and ordinary PCs side by side? Or will an NPU become as standard as the GPU? Dell certainly doesn't think the distinction will last much beyond the short to medium term.

"For the time being, I think there are going to be two versions [of PCs]," said Meghana Patwardhan, vice president of commercial client products at Dell. "If you think about all of the desktop market, [it's] still not fully on NPU at this point of time.

"Eventually, I believe that our customers are going to adopt AI across the board and you are going to see whether it's building your own large language models and making use of the NPU on the PC, whether it's using [a third-party] application, whether it's using what Microsoft or Google or others are developing, every PC is going to be an AI PC in the longer term."

© INTEL

Intel's Core Ultra chips are being used by over 100 software developers

Ben's Bites newsletter (bensbites.beehiiv.com), for example, and you'll find multiple new AI product launches announced every day. Butler predicts you won't have to wait too long to see exciting new product launches that tap the capabilities of AI PCs, either. "I think if you just project forward near term—like in months, quarters, not years—you're going to see a lot more capability coming," he said.

Kevin Terwilliger agrees that we're only just getting started with AI PC apps. "We're just at the tip of the spear when it comes to all these AI capabilities," he said. "Intel has talked about the 100+ ISVs [software developers] that are utilizing the Core Ultra processor. And then what we also see as a great example, companies like Dell, large organizations, are developing new AI capabilities to roll out to their end users internally. That's going to take advantage of this NPU to be able to run efficiently and not have to move a bunch of data into the cloud."

Lenovo isn't planning to leave it to third-party developers to come up with AI software, either. At CES, it showed off prototypes of its own AI apps that took advantage of the NPU, instead of relying on the cloud. The company's AI Now platform includes a Windows Copilot rival that is able to alter operating system functions, as well as perform tasks such as summarizing long documents and writing emails, all without data being sucked into the cloud. Currently, it only plans to release AI Now in China, but it's indicative of a coming shift from cloud to local AI processing.

"If you think about AI in general right now, most of it is cloud-based," said Butler. "And that opens up latency concerns, security and privacy concerns. And so the ability to bring that down to the edge device not only overcomes some of those hurdles, but it also makes it more personal, like you're working on your work for you, not a broad, open public cloud-based platform."

A big advantage of local AI software is that it could access the different apps and data piles stored on your PC, rather than being restricted to files that you upload to the cloud. Butler said you can think of this as an "orchestration layer", capable of bringing together the capabilities of different apps, working with system-wide data. "It's almost at that point a prompt-led conversation with your system, not 'let me open this app to accomplish a task'."

He envisages a future where you'll tell the AI that you want to accomplish a specific task and it will tell you the best, most efficient path to achieve that using the resources and apps you have available on your particular PC. "That's not in the market or present today, but that's effectively what you want to drive to from an AI perspective," he said.

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THE EASY WAY TO RUN LLMs LOCALLY

It's a misconception that you need the huge processing power of cloud servers to run large language models (LLMs). It's possible to run LLMs locally on relatively modestly powered PCs, even without an NPU or dedicated graphics.

If you've ever tried to download and run an LLM locally, you may have been put off by the need for prerequisites, environments, and web UIs to make it all work. However, there is an easier way.

The free LM Studio (lmstudio.ai) for Windows, Mac, or Linux lets you download and run LLMs without any of the faff. You simply choose which LLM you want to run, either by picking from a selection on the home screen or typing its name into the search bar, and it downloads and runs them.

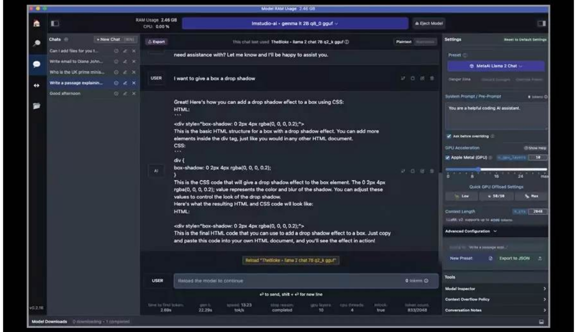
At the time of writing, available LLMs included Google's recently released Qwen from the Alibaba group, and Code Llama from Meta. LM Studio gives handy descriptions of the LLMs featured on the homepage to help you choose, as well as details of how much memory they'll require to run and the size of the download. Most LLMs are between 2-10GB.

Once you've made your choice, click the Chat icon on the left, select the model you want to interact with, and start chatting. If you can't see the USER chat field, close the download pane in the bottom half of the screen to reveal it.

On the right-hand side, you should be able to access the LLMs settings. Here, you can normally enter a system or pre-prompt that tells the LLM how you want to it behave. For example, 'Give answers as if explaining to a five-year-old' or 'assume technical knowledge'. You can also choose the level of GPU acceleration, prompt overflow settings, and more.

Chatting with local LLMs requires a different mindset to using ChatGPT, Copilot, or Google Gemini, which have access to live internet data. Its knowledge will be limited to the recency of its training data. For example, Meta's Llama 2 model told us Boris Johnson was the "current Prime Minister of the United Kingdom", while Google Gemini replied, "As of October 26, 2023, the UK Prime Minister is Rishi Sunak".

But, as we've discussed many times, using these AI engines as fact checkers/search engines is a bad idea. They're more useful for generating text (give it a few bullet points, let the AI put it into prose) or writing code than acting as a pseudo-Google. These local LLMs are more than capable of these more basic tasks, and won't cost you a penny to run, either.



need assistance with? Let me know and I'll be happy to assist you.

USER I want to give a box a drop shadow

AI
~~~~
Great! Here's how you can add a drop shadow effect to a box using CSS:
HTML:
```
<div style="box-shadow: 0 2px 4px rgba(0, 0, 0, 0.2);">
This is the basic HTML structure for a box with a drop shadow effect. You can add more
elements inside the div tag, just like you would in any other HTML document.
CSS:
```
div {
box-shadow: 0 2px 4px rgba(0, 0, 0, 0.2);
}
This is the CSS code that will give a drop shadow effect to the box element. The 0 2px 4px
rgba(0, 0, 0, 0.2); value represents the color and blur of the shadow. You can adjust these
values to control the look of the drop shadow.
Here's what the resulting HTML and CSS code will look like:
HTML:

<div style="box-shadow: 0 2px 4px rgba(0, 0, 0, 0.2);">
This is the final HTML code that you can use to add a drop shadow effect to a box. Just copy
and paste this code into your own HTML document, and you'll see the effect in action!
~~~~

Reload "TheBloke • llama 2 chat 7B q2_k gguf"

USER Reload the model to continue

You are a helpful coding AI assistant.

☑ Ask before overriding

speed: 13.23 tok/s
stop reason: completed
gpu layers: 10
cpu threads: 4
mlock: true
token count: 833/2048

LM Studio is free, and lets you download and run LLMs on your own local PC.

AI PCs YOU CAN BUY RIGHT NOW

Apple MacBook Air

From $899 from apple.com/us

The M2-powered version of the Apple MacBook Air, priced at $899, uses the same 16-core Neural Engine as its more expensive siblings. It's actually the 10-core GPU (rather than the standard 8-core) that could make the most notable difference when it comes to AI applications.

The Air series is only the cheapest MacBook, of course. At the other end of the extreme, you can buy an M3 Max-powered 14in MacBook Pro from $2,899, where you will benefit from the extra horsepower of a 14-core CPU and a thunderous 30-core GPU.

Apple iMac

From $1,249 from apple.com/us

Apple recently updated its 24in iMac with M3 chips, so you will again benefit from its 16-core NPU alongside the latest Apple silicon. As with the MacBook Air, you can upgrade to a 10-core GPU rather than 8-core for a rather stiff $150, but this gives the benefit of two more USB ports, 1Gbit Ethernet and a Magic Keyboard with Touch ID.

The high price (especially once you start adding more storage and memory) counts against this stylish all-in-one, but then, you really can't argue with its level of quality.

Asus Zenbook Duo UX8406 (2024)

From $1,499 from shop.asus.com

Here's something a little different: a two-screen laptop to rival the likes of HP's Spectre Fold 17. Except here, you reap the benefit of a Core Ultra chip, either the Ultra 7 155H for $1,499 or the Ultra 9 185H for $1,699, and with it some considerable AI potential. Much more than the relatively slow 12th gen Core chips found inside foldable laptops.

As with the Spectre Fold, you can use the Duo in various modes, but it's at its best when you need a main window and a supplementary one. Great for debugging AI programs, perhaps. But we also think it works well as a normal laptop, as the detachable keyboard sits snugly on the base. Our only note of caution is that stock remains thin on the ground.

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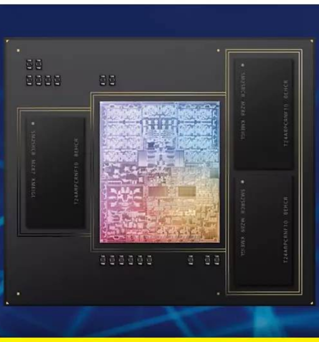
THE PROCESSORS POWERING AI PCs

We've all become used to cores and gigahertz as the key stats for processors, but as we slide deeper into 2024 that is all set to change. Now, silicon makers are starting to talk about TOPS, which stands for trillions (or tera) operations per second. The sheer magnitude of the number here gives you some idea of AI PCs' potential power, as—in the right situation—they can achieve so much in a fraction of a second.

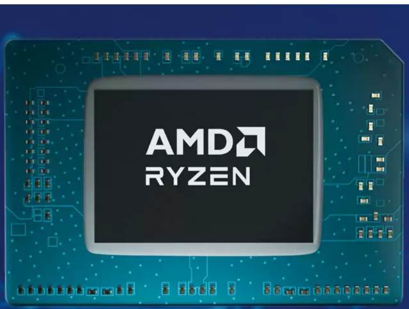
Here, we provide a quick look at what AMD, Apple, Intel, and Qualcomm have to offer with their latest processors.



APPLE M3

18 TOPS (NPU only)

When it comes to NPUs built into silicon, Apple had a head start on its rivals. The M1 appeared in 2020, and while Apple didn't state its power, the internet's best guess (from @t3mporarybl1p on X) is 11.3 TOPS. It's perhaps surprising, then, that the M3 is stuck on 18 TOPS. Apple claims the new MacBook Air is the "world's best consumer laptop for AI". Apple can rely on a strong software ecosystem, not least because developers have been exploiting the Neural Engine for so long.



AMD RYZEN 7040 AND 8040 SERIES

7040: 33 TOPS 8040: 39 TOPS

AMD beat Intel to the AI punch by almost a year, with its CEO Lisa Su announcing the Ryzen 7040 series back in January 2023, and the first laptops available by March last year. Then, in December, it announced the updated 8040 series, with the promise of a boost in performance. It's a bit confusing, as not every 7040 and 8040 series chip includes Ryzen AI—AMD's name for its NPU—so check each processor's listing before buying.

PCSpecialist Fusion Elite P

$784 from pcspecialist.co.uk (UK/Ireland only)

This is one of the most affordable ways to buy an AI PC today, being based on AMD's Ryzen 8600G chip. It comes with respectable integrated graphics, and the latest Ryzen AI with the promise of 16 TOPS speeds, and unlike all the laptops on this page there's room to grow. When budget allows, simply slip a graphics card into the waiting slot.

Surprisingly for the price, you get liquid cooling for the AMD processor, which not only helps maximize its performance but also keeps the noise volume down. So while this PC isn't the height of luxury or expandability due to the budget microATX motherboard, it's a cracking way to start an AI adventure.

Acer Swift Edge 16

$1,299 from store.acer.com

This remains something of a beauty. While the name leads on its slimness—a remarkable 13mm—what struck us most on use was its 1.2kg weight. That came at the expense of battery life, with eight hours in our tests, but that compromise was inevitable. Other than this, compromise isn't in the Edge 16's vocabulary. From the 1440p webcam to the fit and finish, this is a top-quality laptop—and you simply can't argue with that price.

Framework Laptop 16

From $1,399 from frame.work

Whether you want a laptop that will last for a decade or simply desire a number pad that can be fitted on both the right and left, this modular laptop is like no other.

What makes it an AI PC is AMD's Ryzen 7840HS processor (you can choose a Ryzen 9 7940HS too), and with the option of adding an extra 6TB of storage via expansion cards it has the potential to handle even the most demanding of masters.

Samsung Galaxy Book4 Pro 16in

512GB, $1,749 from samsung.com

Intel's Core Ultra range was only launched in December 2023, but there are no shortage of laptops that are powered by its chips. For example, we can confidently predict that dozens of laptops we review this year will end up including various versions of the processor.

Samsung has also proceeded to update its Book range of laptops with Core Ultra CPUs, so if you see Book4 in the name, you know that it's going to be an AI PC. Take the Book4 Pro 16in as an example of this—it's one of the best. Despite the presence of the 16in OLED panel, it's a sleek 12.5mm thick, and exudes what can be described as industrial chic, thanks to its all-metal shell.

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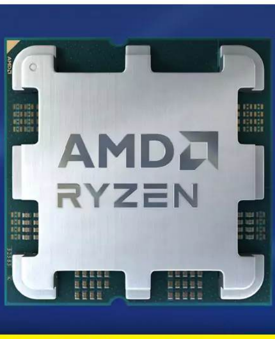

AMD RYZEN 8600G AND 8700G

39 TOPS

AMD has also beaten Intel to the desktop punch when it comes to NPUs built into silicon, announcing the Ryzen 8600G and 8700G chips at CES 2024 in January. Just to muddy things a little, the 8500G and 8300G—announced at the same time—don't include Ryzen AI. Priced at $229 and $328 respectively, these chips both represent an extremely affordable entry into the AI PC world.

intel
CORE
ULTRA

INTEL CORE ULTRA

34 TOPS

Launched in December 2023, Intel's Core Ultra chips were the company's first to feature an NPU. Only 11 Core Ultra processors have been released so far, but they're proving popular with laptop makers: we're already seeing a flurry of machines built on the chips, and Intel reportedly hopes to sell 100 million Core Ultra PCs by 2025. Note that Intel doesn't give its NPU an individual TOPS rating, with its 34 TOPS claim based on the CPU, GPU and NPU combined.

Snapdragon
X
Elite

QUALCOMM SNAPDRAGON X ELITE

75 TOPS

You'll have to wait until mid-2024 for the first AI PCs based on Qualcomm's Snapdragon X Elite, but it promises much. Indeed, at its October 2023 launch, the company claimed it offered "4.5x faster AI NPU processing power than competitors" with its Hexagon NPU capable of 45 TOPS on its own (75 TOPS once you include the CPU and GPU). That figure compared it to the 10 NPU TOPS of the Ryzen 7040, but AMD's Ryzen AI now offers 16 TOPS.

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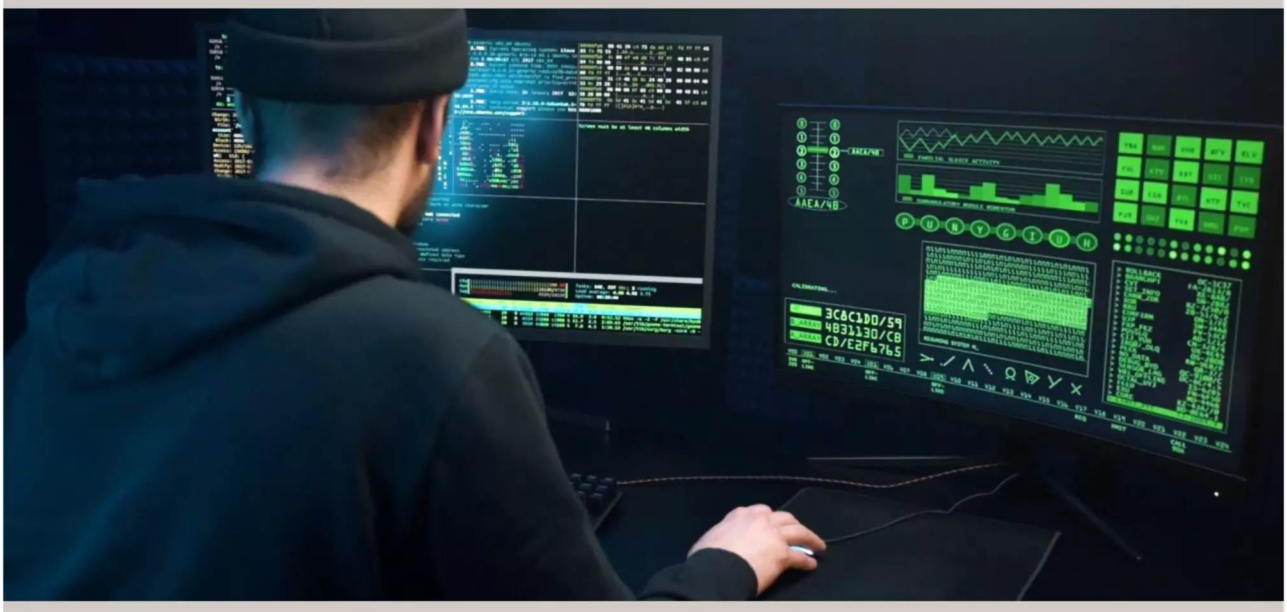
SAFEGUARD YOUR PC SECURITY FOR 2024



Nate Drake explores some of the more insidious cybersecurity threats of 2024, as well as ways to keep your PC safe

The internet has never been more dangerous. In April, a Microsoft Employee stumbled across a cunningly coded Linux backdoor that could have compromised virtually every major website.

Generative AI promises to transform users' desktop experience. But cybercriminals are using LLMs to generate well-written phishing messages, as well as malicious code.

Traditional ways to protect your online privacy like VPNs are also being undermined by increasingly sophisticated 'fingerprinting' techniques.

Protecting your PC is largely a matter of developing good habits such as regular updates and using integrated tools. In this guide, you'll gain some insight into the state of cybersecurity for 2024, as well as some ways to keep your device safe.

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SECURE BROWSERS

POSITIVES

- **Easier detection of bugs**
- **Compatible with privacy plugins**
- **Resistant to browser fingerprinting**

NEGATIVES

- **Can't protect against all phishing**
- **NoScript can make pages load incorrectly**
- **Tor Browser is slow**

AS ONE of the most commonly used web applications, browsers are a prime target for cyberattacks. According to a recent report by Menlo Security, browser-based phishing attacks increased by 198 percent in the last year.

It's likely that this trend will continue in 2024, with common attacks including SMS phishing (smishing), Adversary in the Middle (AITM) frameworks, image-based phishing, and attempts to bypass MFA (multi-factor authentication).

In early 2024, Apple patched a 'zero day' exploit in its WebKit browser engine for Safari. They claimed this bug could be used by hackers to remotely execute code, though they didn't go into further details.

A major bug was also discovered in Chrome in early 2024, which could be exploited by hackers using a crafted HTML page. This was considered extremely serious, as it seems that hackers had already been taking advantage of it.

Whichever browser you use, the best protection against 'zero day' bugs is to keep your software up to date. This may sound obvious, but many cybercriminals rely on our very human tendency to click 'Update Later'.

The steps for updating will vary by browser. In Chrome, for instance, you can click more (...) > Help > About Google Chrome > Update Google Chrome. If you don't see this, then Chrome is up-to-date.

When it comes to browser security, adopt Linus' law: 'Given enough eyeballs, all bugs are shallow'. In this case, this means you're safer using a reliable open-source web browser over proprietary ones like Chrome and Safari. As the code is publicly available, it's more likely that bugs will be discovered and patched.

Security expert Manfred Paul aptly demonstrated this in late March by announcing his discovery of two major vulnerabilities in the Firefox browser at a two-day 'hackathon' in Vancouver. Both could be used to inject arbitrary JavaScript code. Mozilla issued a patch, and awarded Paul a $100,000 bug bounty.

Even when the code acts as it should, according to a March 2024 article by programmer Nikita Prokopov, JavaScript on web pages is becoming bloated, not only making for slower loading times, but increasing your attack surface.

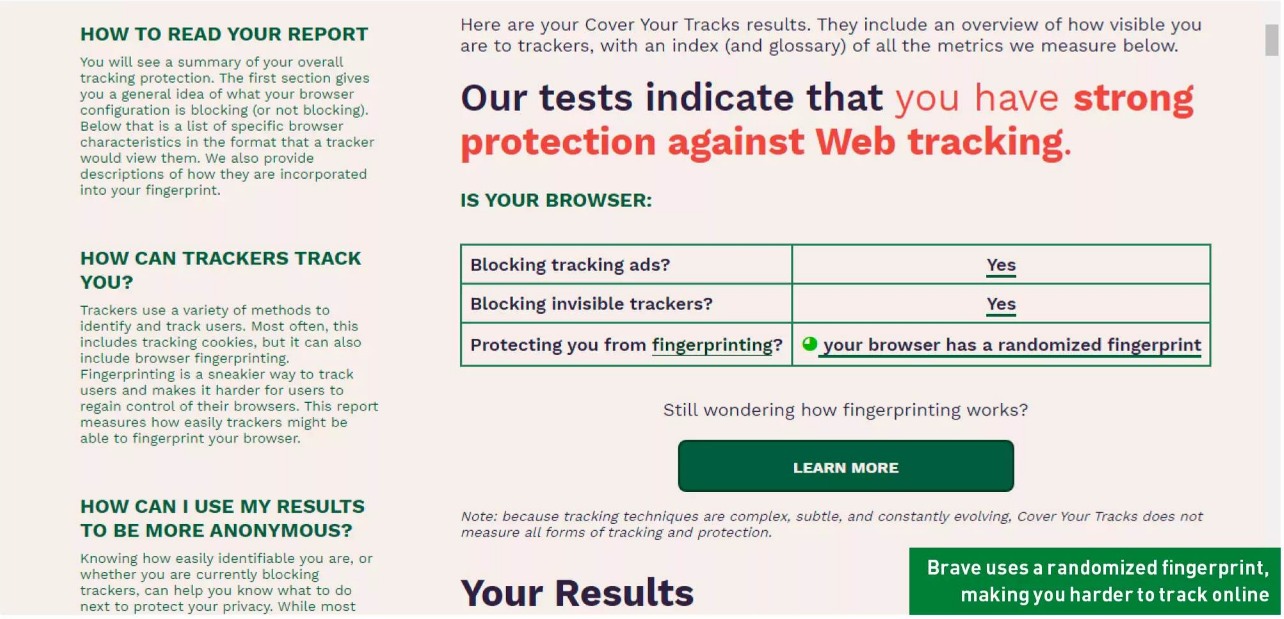
One of the best ways to tackle this is through using the browser plug-in NoScript (https://noscript.net/), which blocks arbitrary code from executing on web pages. You can, of course, permit specific scripts to run or allow JavaScript globally on sites you know are safe. The plugin comes bundled with certain programs, like the Tor browser, but can also be installed via sites like the Firefox Add Ons Page and the Chrome Web Store.

NoScript also offers excellent protection against 'browser fingerprinting', where sites analyze your browser configuration like your screen resolution, supported languages, installed fonts, and so on to form a unique 'fingerprint' of your activity. This is usually done for advertising purposes, but can be used to identify you, even if you've hidden your IP address by a VPN or proxy.

In April 2024, Kevin Cryan, Director of Operational Intelligence at Fortra's PhishLabs noted that cybercriminals are using browser fingerprinting, and that sites are getting better at detecting browsers trying to send fake data to avoid this. There are websites, like EFF's 'Cover Your Tracks' (https://coveryourtracks.eff.org), that can determine the uniqueness of your browser fingerprint.

Although NoScript provides the best protection, new fingerprinting methods are being discovered. This means you'll surf most safely in 2024 by using a privacy-focused web browser.The Tor Browser is an excellent case in point, as it's designed so that all users appear to have the same fingerprint. However, as all connections are routed through the Tor network, it's not suitable for day-to-day browsing.

The open-source Brave browser (https://brave.com) is designed to resist fingerprinting by sending randomized data to websites, making your browser much harder to profile.



HOW TO READ YOUR REPORT

You will see a summary of your overall tracking protection. The first section gives you a general idea of what your browser configuration is blocking (or not blocking). Below that is a list of specific browser characteristics in the format that a tracker would view them. We also provide descriptions of how they are incorporated into your fingerprint.

HOW CAN TRACKERS TRACK YOU?

Trackers use a variety of methods to identify and track users. Most often, this includes tracking cookies, but it can also include browser fingerprinting. Fingerprinting is a sneakier way to track users and makes it harder for users to regain control of their browsers. This report measures how easily trackers might be able to fingerprint your browser.

HOW CAN I USE MY RESULTS TO BE MORE ANONYMOUS?

Knowing how easily identifiable you are, or whether you are currently blocking trackers, can help you know what to do next to protect your privacy. While most

Here are your Cover Your Tracks results. They include an overview of how visible you are to trackers, with an index (and glossary) of all the metrics we measure below.

Our tests indicate that you have strong protection against Web tracking.

IS YOUR BROWSER:

Blocking tracking ads?	Yes
Blocking invisible trackers?	Yes
Protecting you from fingerprinting?	● your browser has a randomized fingerprint

Still wondering how fingerprinting works?

Note: because tracking techniques are complex, subtle, and constantly evolving, Cover Your Tracks does not measure all forms of tracking and protection.

Your Results

Brave uses a randomized fingerprint, making you harder to track online

© BRAVE

ENCRYPTION

POSITIVES

- Quantum-proofing protects against HNDL attacks
- AES already quantum protected
- Bitlocker still protects devices with fTPM

NEGATIVES

- Won't protect against government backdoors
- Q Day is far off
- Other exploits remain

IN LATE 2023, the UK's 'Online Safety Bill' was passed into law. Some more controversial parts of the act included provisions to force online platforms to scan messages for illegal material. This would undermine the 'end-to-end' encryption offered by such platforms.

Naturally, this would have huge implications for user privacy. In the past year, representatives of companies like Apple, Signal, and Meta have threatened to leave the UK rather than comply.

So far, the UK government hasn't forced the point, and products like WhatsApp, Telegram, and Signal are still freely available for download in Britain.

In the meantime, platforms have been upping their encryption game. In late 2023, Signal announced that Signal Protocol encryption is now 'quantum resistant'. As such, readers who need quantum-resistant secure messaging need only to download the app via https://signal.org. This type of 'quantum-proofing' provides excellent protection against HNDL (Harvest Now, Decrypt Later) attacks.

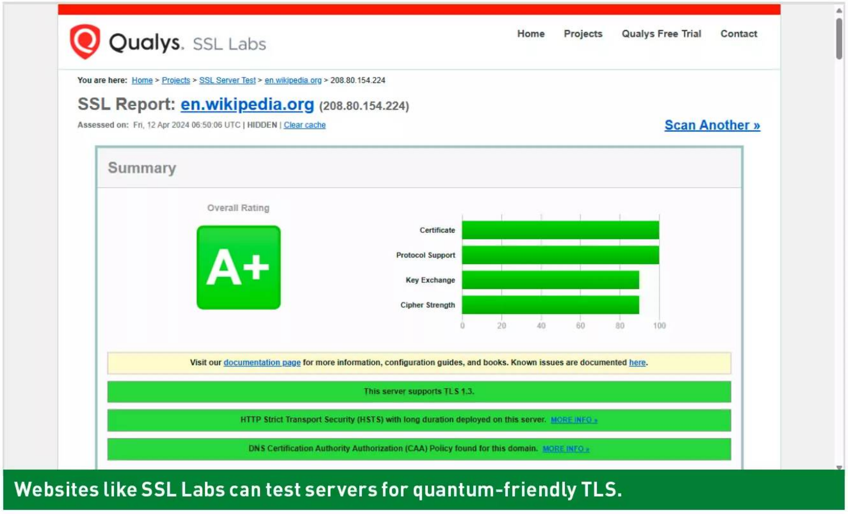
These types of attacks involve recording encrypted data like web traffic in anticipation of 'Q Day'. This is the future date when quantum computers will be capable of generating enough Qubits to break traditional key-based cryptography.

Tech companies aren't sitting on their hands. As of April 2024, Cloudflare has secured around two percent of all TLS 1.3 connections with post-quantum cryptography, and hopes to see double-digit adoption by the end of the year. The NSA is taking a more circumspect approach by aiming for full post-quantum migration of all their products by 2033.

Although 2024 is definitely not the year a quantum computer will be built to threaten conventional encryption, the threat is very real. A sufficiently powerful computer running Shor's 'quantum algorithm' could crack public key cryptosystems like RSA, which rely on multiplication and factorization of large prime numbers. Effectively, this would allow the operator of the quantum computer to decrypt all secure web traffic between users' browsers and sites.

Recent advances in 2024 have brought this possibility closer. Quantum computers are inherently analog and subject to 'noise', which can interfere with mathematical operations like breaking encryption. Still, in the past year, there have been significant strides in 'Quantum Error Correction' codes, which in theory could transform many millions of noisy 'qubits' into a small powerhouse of effective ones, capable of breaking public key encryption, such as that used by RSA.

Currently, almost all secure web traffic is secured via X25519, a Diffie–Hellman-style key agreement. This is typically performed by a TLS 'handshake' between a web application like a browser and the server so they can agree on a shared encryption key.



You are here: Home > Projects > SSL Server Test > en.wikipedia.org > 208.80.154.224

SSL Report: en.wikipedia.org (208.80.154.224)

Assessed on: Fri, 12 Apr 2024 06:50:06 UTC | HIDDEN | Clear cache

Visit our documentation page for more information, configuration guides, and books. Known issues are documented here.

This server supports TLS 1.3.

HTTP Strict Transport Security (HSTS) with long duration deployed on this server. MORE INFO »

DNS Certification Authority Authorization (CAA) Policy found for this domain. MORE INFO »

Websites like SSL Labs can test servers for quantum-friendly TLS.

© SSL LABS

While there's no feasible way to rapidly break the encryption, the security of X25519 is based on the 'discrete logarithm problem for elliptic curves', which could be cracked by a future quantum computer. This means any handshakes recorded now as part of an HNDL attack could be used to decrypt associated web traffic.

Organizations like Cloudflare and Google's Chrome team have responded to this by adopting ML-KEM (previously known as 'Kyber') to secure web traffic. This 'key encapsulation mechanism' is quantum-resistant, though the full standards for its operation likely won't be fully put in place by NIST until 2025.

As an avid PC user, there are things you can do to ensure your online safety in a post-quantum world. First, you should favor products and services like Signal and Cloudflare that are quantum-resistant. SSL Labs also has a free online testing tool (www.ssllabs.com/ssltest), which you can use to check that your favorite websites are using a version of TLS with quantum support (currently 1.3).

256-Bit Symmetric ciphers like AES and Twofish are generally considered 'quantum safe'. While an advanced quantum computer running 'Grover's Algorithm' could reduce the time required to brute-force a password, provided the key is long enough it would still be unfeasible to break in someone's lifetime.

This won't come as much comfort to those who use Microsoft's BitLocker to encrypt their Windows drive. In February 2024, security researcher StackSmashing demonstrated an exploit using a $10 Raspberry Pi Pico to quickly break BitLocker's drive encryption. In fairness. the vulnerability is well-established, even referenced in Microsoft's technical documentation. It also only affects devices that have standalone TPM (Trusted Platform Module) chips.

These are rarer these days, as most computers use firmware TPM modules (fTPM), which are integrated into the processor. If you're unsure what you have, simply enter 'security' into your Windows 11 search bar to open 'Windows Security'. After this, select 'Device Security' from the left-hand pane, then choose 'Security processor details'.

From here, you can see the 'manufacturer' name. If this matches your CPU manufacturer, ie. Intel or AMD, then it's likely that you're using an fTPM, so your device's encryption can't be broken in this way.

RANSOMWARE PROTECTION

POSITIVES

- **Lower year-on-year payments**
- **Lockbit Gang taken down**
- **Windows has anti-ransomware features**

NEGATIVES

- **Windows Security can cause runtime issues**
- **Antivirus isn't always effective**
- **Uninstalling Windows isn't always feasible**

2023 SAW a huge spike in ransomware, with a 55 percent increase in victims worldwide, at a cost of over $1 billion. The tide turned towards the end of 2023, with Malwarebytes reporting that in the last quarter of 2023, only 29 percent of ransomware victims paid up.

2024 brought more good news, as in February, the FBI and various international law enforcement agencies took down the notorious 'Lockbit' ransomware group.

According to a report by Coveware, the average ransomware payment is also proportionately much lower than in 2023. Although antivirus software can protect against some forms of ransomware, it's not as effective once malware has gained a foothold in your system.

Windows 10 and 11 can provide some protection against this via 'Controlled Folder Access'. Once enabled, the operating system will only allow 'trusted' apps to access files in specific folders.

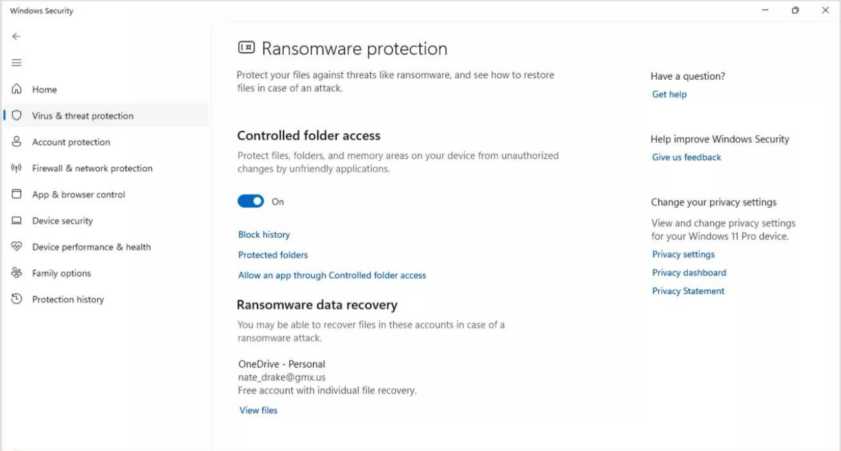
To enable this feature on Windows 11, enter 'Security' in the Windows search bar to launch 'Windows Security'. Next, choose 'Virus and Threat Protection' from the left-hand pane. Scroll to the section marked 'Ransomware protection' and click 'Manage Ransomware protection'.

Here, you can enable 'Controlled Folder Access'. By default, only your personal folders are secured, but you can select 'Protected Folders' to add others. Readers may wonder why this feature isn't enabled out of the box in Windows. This is simply because there are legitimate apps that aren't on Windows' 'trusted' list, which can cause runtime errors.

Ransomware payloads are often introduced via 'phishing' links in emails and/or websites. Use a dedicated email client with link scanning built in, like Thunderbird's 'Scam Detection' or Office365's 'Safe Links'. When surfing the web, you can eliminate most harmful links through using a reliable ad blocking browser extension, like uBlock Origin (https://ublockorigin.com).

While Ransomware exists for most operating systems, it remains most prevalent on Windows. This means you can reduce the chance of a compromised system by using Linux on your PC.

Admittedly, malware for Linux is on the rise, but as most popular versions like Ubuntu are open-source, bugs are easy for the community to fix. Linux is designed with security in mind—by default, programs can only be installed by dedicated 'package managers'. The OS also strictly defines access permissions for files and programs.



Ransomware protection

Protect your files against threats like ransomware, and see how to restore files in case of an attack.

Controlled folder access

Protect files, folders, and memory areas on your device from unauthorized changes by unfriendly applications.

On

Ransomware data recovery

You may be able to recover files in these accounts in case of a ransomware attack.

OneDrive - Personal
nate_drake@gmx.us
Free account with individual file recovery.

View and change privacy settings for your Windows 11 Pro device.

Controlled Folder Access allows only certain apps access to your files.

© MICROSOFT

PHISHING

POSITIVES

- MFA still the best defense
- DNS filtering also offers protection

NEGATIVES

- MFA isn't always effective
- Malicious URLs harder to detect

According to Egress's 'Email Security Risk Report' for 2024, 94 percent of organizations have been targeted by phishing attacks. It remains the most common method for delivering ransomware and other types of malware, from both real and fake accounts.

In cases where phishing is designed to harvest user credentials, traditional advice has been to enable MFA (multi-factor authentication) so that even if a hacker obtains your passphrase, they'll need a six-digit OTP (one-time password).

According to Proofpoint's 2024 'State of the Phish' report, however, this is becoming less effective against Adversary-in-the-Middle (AitM) phishing 'kits' like EvilProxy, which steal credentials and session cookies in real time. This involves cybercriminals setting up a fake domain, impersonating a legitimate site, then tricking the user into trying to log in with their credentials and OTP. The hacker can intercept this data and send it to the real server in order to obtain a valid session cookie and log in.

The same report notes that attackers are less likely to place direct links to phishing domains in emails or text messages ('smishing). Instead, they're inserting links to legitimate websites like YouTube, whose URLs include redirect links to phishing domains. Attackers are also using LLMs to craft plausible messages, less likely to contain spelling or grammar errors. Microsoft seems to be the most abused brand, with 68 million malicious messages associated with it.

MFA remains an excellent way to secure online accounts, though we recommend a dedicated open-source app like FreeOTP rather than SMS to receive codes. Since malicious URLs are becoming harder for humans to detect, you should also consider using a reliable DNS service like OpenDNS, which will block known phishing domains.

FIREWALLS

POSITIVES

- **Protects against unauthorized remote access**
- **Free version built in to Windows**
- **Simple to configure**

NEGATIVES

- **Can still be compromised**
- **False positives**
- **Lacks some advanced features (Windows)**

IN APRIL, malware hunters at Volexity discovered a 'zero day' exploit in Palo Alto Networks' firewalls, which they claimed a bad actor had been deploying for weeks. The vulnerability was given the highest CVE (Common Vulnerabilities and Exposures) rating of 10, as it allows unauthorized users to inject arbitrary code and execute commands with root privileges, effectively rendering the firewall useless. At the time of writing, a patch is still being prepared.

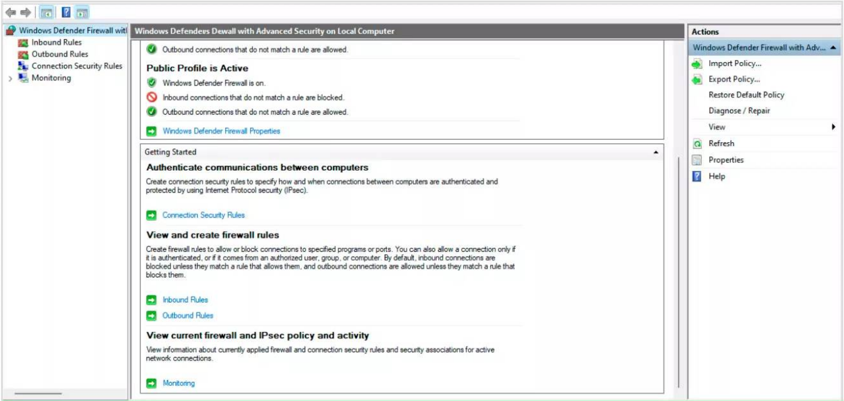
With the rise of ZTNA (Zero Trust Network Access), which can repeatedly request device and user authentication to access resources, there have been a number of articles calling traditional firewalls redundant, given that once a user is authenticated by one, they're usually given full access to the network.

While this is a meaningful discussion for network administrators, there's no debate for regular PC users. A robust and up-to-date firewall still provides excellent protection against bad actors trying to remotely access your device.

In Windows 11, the firewall falls under the umbrella of 'Windows Security'. You can access it by typing 'firewall' into the Windows search bar to open 'Firewall & network protection.' By default, Windows' firewall enables three profiles: Domain, Private, and Public. Firewall settings will vary depending on your profile—on public networks, incoming connections are blocked unless they're from a list of allowed apps. You can, however, edit this list. The firewall also supports Internet Protocol security (IPsec), which means you require authentication from any device attempting to communicate with yours. You can configure this from the 'Windows Firewall with Advanced Security console', and define rules for connections.

Overall, Windows Security offers an excellent personal firewall, which is something to consider before installing a third-party one. The only real justification for these are the extra features, such as ZoneAlarm's automatic scanning of URLs for phishing links.

TinyWall is one exception to this rule, as it's designed to work alongside Windows Defender, minus annoying pop-up notifications.


Windows Defender Firewall wit
Inbound Rules
Outbound Rules
Connection Security Rules
Monitoring
Windows Defenders Dewall with Advanced Security on Local Computer
Actions
Windows Defender Firewall with Adv...
Import Policy...
Export Policy...
Restore Default Policy
Diagnose / Repair
View
Refresh
Properties
Help

Outbound connections that do not match a rule are allowed.

Public Profile is Active

Windows Defender Firewall is on.

Inbound connections that do not match a rule are blocked.

Outbound connections that do not match a rule are allowed.

Windows Defender Firewall Properties

Getting Started

Authenticate communications between computers

Create connection security rules to specify how and when connections between computers are authenticated and protected by using Internet Protocol security (IPsec).

Connection Security Rules

View and create firewall rules

Create firewall rules to allow or block connections to specified programs or ports. You can also allow a connection only if it is authenticated, or if it comes from an authorized user, group, or computer. By default, inbound connections are blocked unless they match a rule that allows them, and outbound connections are allowed unless they match a rule that blocks them.

Inbound Rules

Outbound Rules

View current firewall and IPsec policy and activity

View information about currently applied firewall and connection security rules and security associations for active network connections.

Monitoring

Windows Firewall is enabled by default and highly configurable.

VPNs

POSITIVES

- Can circumvent geo restrictions
- Encrypts traffic with VPN server
- Evades censorship

NEGATIVES

- Free VPNs can be dangerous
- Proprietary VPN clients
- Risk of DNS Leak

According to Forbes Advisor, two thirds of people now use a VPN to protect their data. Traditionally, VPN services have been popular for overcoming geo restrictions on platforms like Netflix.

The benefits of using a reliable VPN provider are clear, given that traffic between a user's device and server is encrypted. This is especially useful on unsecured public Wi-Fi networks, where bad actors can monitor data packets.

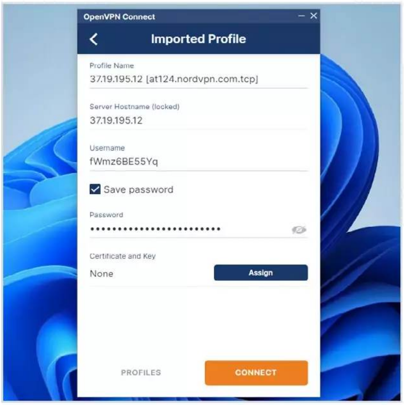
VPNs are also an important tool for circumventing censorship. This is particularly relevant in 2024, as at the time of writing, 17 states have passed or introduced laws requiring age verification for internet users to access certain websites.

In March, adult site Pornhub 'went dark' in Texas in protest, having done the same in Montana and North Carolina in January. The site's operator, MindGeek, pointed out that the requirement to provide government documents for age verification has huge privacy implications, given it would be easy to identify people's browsing habits. Unless such data is secured, it would put customers at risk of identity theft. Affected users need only connect to a VPN server based in a state that doesn't have such checks.

Currently, around half of VPN users make use of 'free' services. This in spite of the well-documented dangers, such as the 2023 leak of over 360 million customer records after a breach of free provider SuperVPN.

Cybersecurity researcher Jeremiah Fowler documented this breach, and discovered multiple versions of the 'SuperVPN' app offered for download, seemingly by separate developers. His findings showed a link between the creators of SuperVPN and other supposedly free services like Storm VPN, Luna VPN, Rocket VPN, and Ghost VPN.

While users may balk at the extra cost, running an effective VPN service



Profile Name: 37.19.195.12 [at124.nordvpn.com.tcp]

Server Hostname (locked): 37.19.195.12

Username: fWmz6BE55Yq

☑ Save password

Password: ••••••••••••••••••••••••

Certificate and Key: None

Open-source VPN clients like OpenVPN Connect offer the best security.

© MICROSOFT, OPENVPN

ANTIVIRUS

POSITIVES

- Can prevent malware executing
- Windows Defender offers great protection
- Extra features

NEGATIVES

- Not effective against all malware
- Last line of defense
- False positives

WHILE TOOLS like ChatGPT have safeguards to prevent generating malicious codes, the same isn't true for all LLMs, meaning AI can be deployed to generate polymorphic malware.

One such tool, BlackMamba, was developed as a proof of concept last year by Hyas. This particular malware was a form of keylogger, capable of retrieving code from a 'benign' source like Pastebin, then changing it constantly to avoid detection algorithms.

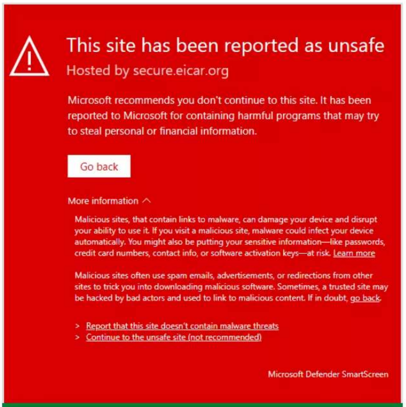
BlackMamba was tested multiple times on an anonymous big name EDR (Endpoint Detection and Response) platform, only for it to fail to recognize the threat. EDR platforms have been keen to fight fire with fire, and there are currently many solutions on the market using machine learning to isolate threats.

Still, the grim outlook for threat detection in the wake of AI has led to serious concerns that traditional antivirus simply can't keep up. As far back as 2014, the CEO of Symantec admitted that antivirus alone wasn't sufficient to keep up with modern threats. In the years since these comments have been widely misquoted as a proclamation that "antivirus is dead."

It's more accurate to say that antivirus is a last line of defense: where DNS filtering or browser plugins fail to block a harmful download, or firewalls fail to prevent delivery of malicious payloads, the antivirus is left to succeed where other products failed.

Popular website AV-Test scans an average of 12 million harmful programs each month, as well as reviewing various antivirus projects. It also maintains a carefully curated list of the very best Windows antivirus software for home users.

Choosing from these can be difficult, as antivirus developers try to make their products stand out by offering extra features like password managers, VPN, secure browsers and the like. As useful as these can be, they can distract from the core issue of how efficient the software is at detecting and removing malware.



This site has been reported as unsafe

Hosted by secure.eicar.org

Microsoft recommends you don't continue to this site. It has been reported to Microsoft for containing harmful programs that may try to steal personal or financial information.

Malicious sites, that contain links to malware, can damage your device and disrupt your ability to use it. If you visit a malicious site, malware could infect your device automatically. You might also be putting your sensitive information—like passwords, credit card numbers, contact info, or software activation keys—at risk. Learn more

Malicious sites often use spam emails, advertisements, or redirections from other sites to trick you into downloading malicious software. Sometimes, a trusted site may be hacked by bad actors and used to link to malicious content. If in doubt, go back.

> Report that this site doesn't contain malware threats
> Continue to the unsafe site (not recommended)

Microsoft Defender SmartScreen

Microsoft SmartScreen can prevent download of potentially malicious files.

During January and February 2024, AV-Test evaluated 17 of the most popular antivirus solutions. These tests included Windows' own built-in antivirus, which can be accessed via Windows Defender Security Center in 'Settings'.

AV-Test first used 278 samples to test Windows' built-in protection against zero day malware attacks, including web and email threats. They also tested Windows Defender against 15,362 known samples of malware that had been discovered in the previous four weeks. In both cases, the detection rate was 100 percent.

Admittedly, there are third-party products that achieved the same results and which, like Windows Defender, received AV-Test's 'Top Product' rating. Still, it's comforting to know that Windows already offers comparable antivirus protection to leading paid products such as Bitdefender Total Security.

Windows Defender also includes Microsoft SmartScreen. Each time a user tries to install an app, SmartScreen attempts to confirm it's legitimate by checking the publisher's digital signature and verifying the certificate authority via a 'Chain of Trust'.

SmartScreen can also check that domains are safe for Microsoft Edge users, though this has resulted in false positives, such as in March 2023, when Windows Defender started blocking a number of legitimate websites.

Still, given that Windows' own antivirus is available for free and can automatically be updated along with the OS, it has clear advantages over a third-party product. As with any security software, it pays to do your own research through reading independent online reviews before installing.

consumes huge resources in terms of bandwidth, servers, and maintenance. If a provider is offering a VPN service for free, there's a risk that they're harvesting user data to sell and/or serving ads that could undermine your privacy.

Note that there's a distinction between cost-free VPN services and reliable VPN providers who offer both free and paid plans. As such, Fowler's advice from 2023 remains current. When considering a VPN provider, read independent online reviews from sites like TechRadar to check they're legitimate and their service will meet your needs. Ideally, find a provider who either offers a free trial or a money-back guarantee.

Many VPN services claim to have a 'no logs' policy where they do not permanently store identifiable information about users. In theory, this provides excellent protection if any VPN servers are compromised or seized. In practice, this is an easy claim to make, so some of the bigger VPN providers submit to regular audits by third parties to verify this. For instance, in January 2024, NordVPN underwent an audit with Deloitte Audit Lithuania, who inspected the provider's server infrastructure to check the no-logs policy was still in place.

Linus' Law also applies to VPNs. If the 'client' software you use to connect to the service is open-source, it's not only less likely to contain bugs, but you can be assured that there are no 'backdoors' to allow bad actors to monitor your activity.

If your provider doesn't offer this, consider connecting to their service via an open-source third-party client, like SoftEther or OpenVPN Connect. Make sure your VPN services also supports protocols using strong encryption like WireGuard or OpenVPN.

Certain VPN providers will encrypt traffic correctly, but leave your device's DNS requests to be handled by your ISP. This form of 'DNS Leak' is a privacy risk, as anyone with access to your ISP's record can see what domains you visit. More reliable VPN services will process your DNS request themselves. You can check this is the case when connected to your VPN via tools like https://ipleak.net.

© EICAR

CENTERFOLD

PERFO E GEAR LAID BARE

PlanetPC XR2 Mini Desktop

IF YOU'RE BORED of conventional tower rigs or x86-based mini PCs, then get a load of the new PlanetPC XR2 Mini Desktop. The idea is a zero-configuration Linux PC. No more searching for drivers, compiling or configuring obscure parameters; just a usable Linux machine running Ubuntu.

Novelties include an integrated color touchscreen with 1,424 by 280 pixel resolution, giving access to soft keys, a system monitor, and controls for Wi-Fi, Bluetooth, audio, and other system functions. Connectivity is another strong point, with two HDMI out ports with support for up to 8K resolutions, an HDMI-in for capturing video up to 4K, dual ethernet, microSD, USB-C, and even a legacy VGA port.

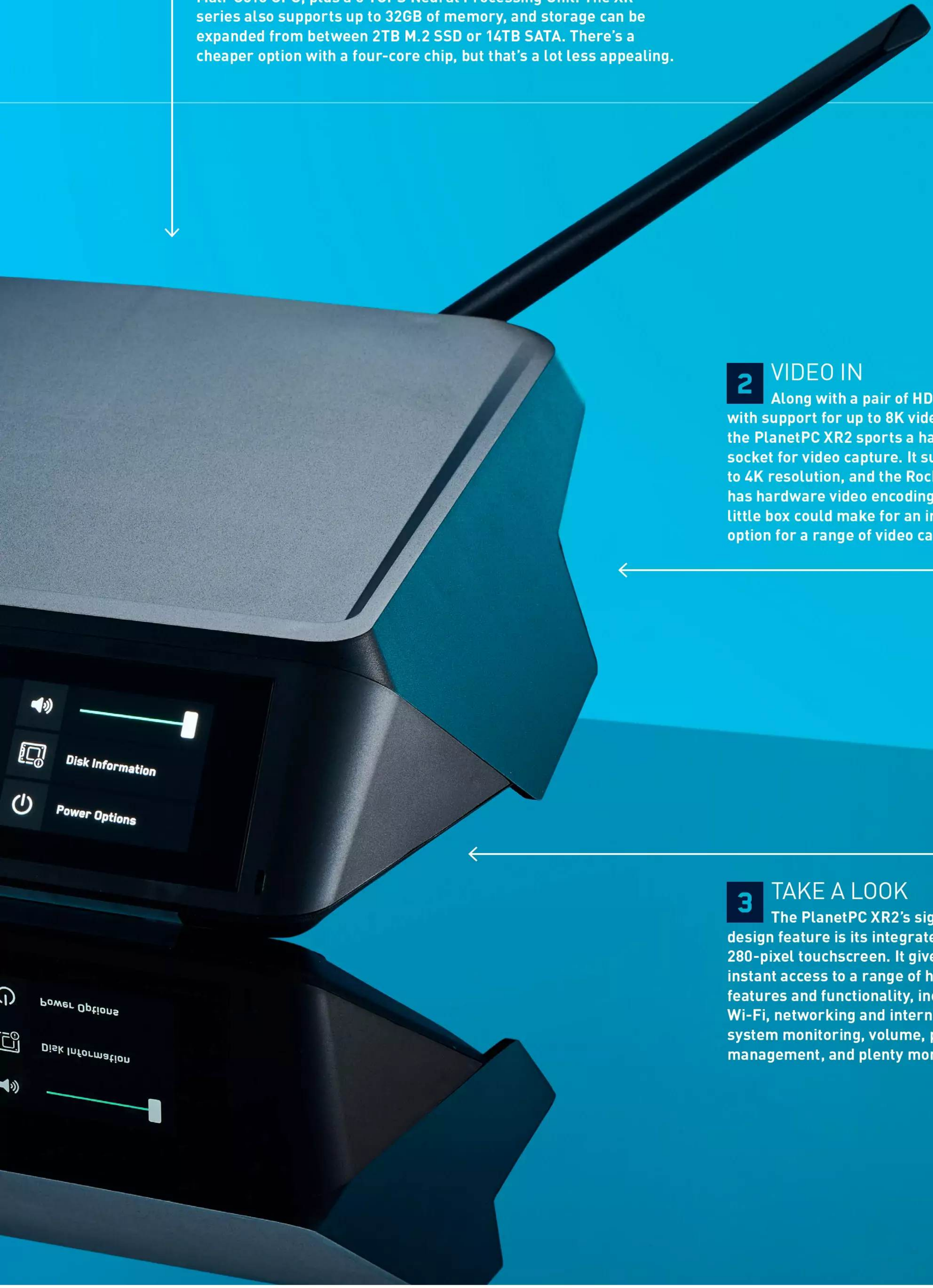
Oh, we forgot to mention that this is an Arm-based rig running the intriguing RockChip RK3588 SoC. It sports four Arm Cortex-A76 high-performance cores, and another four Cortex-A55 efficiency cores. To that, you can add an Arm Mali-G610 MP4 quad-core GPU and an NPU, with 6 TOPS of AI processing throughput. There are even stereo speakers and a microphone.

It's not the cheapest mini PC, at $721 for 8GB memory and 64GB flash storage configuration. Up to 32GB of RAM and over 10TB of storage is supported—you probably wouldn't want to game on it, but as an accessible route into Linux and Arm computing, it's an intriguing turn-key with lots of useful features. **–MAXIMUM PC**

11:13
20/03/2024
Connection Status
PC Monitor
Settings
WiFi
Not Connected
Hotspot
Off
Lock Screen

1 FULLY FEATURED

The XR2 rocks an eight-core Arm SoC processor with a Mali-G610 GPU, plus a 6 TOPS Neural Processing Unit. The XR series also supports up to 32GB of memory, and storage can be expanded from between 2TB M.2 SSD or 14TB SATA. There's a cheaper option with a four-core chip, but that's a lot less appealing.



2 VIDEO IN

Along with a pair of HDMI ports with support for up to 8K video output, the PlanetPC XR2 sports a handy HDMI-in socket for video capture. It supports up to 4K resolution, and the RockChip SoC has hardware video encoding, so this little box could make for an intriguing option for a range of video capture tasks.

3 TAKE A LOOK

The PlanetPC XR2's signature design feature is its integrated 1,424 by 280-pixel touchscreen. It gives you instant access to a range of handy features and functionality, including Wi-Fi, networking and internet access, system monitoring, volume, power management, and plenty more besides.

CREATE A SECURE WIREGUARD VPN SERVER

© GETTY IMAGES/MIHAILOMILOVANOVIC

Discover how to securely access your home network when out and about, with *Nick Peers*

THE BENEFITS OF VPNs—Virtual Private Networks—are well-known, particularly when it comes to securing your connection to the internet. Nate Drake's excellent feature in the October 2023 issue explains how that side of VPNs work, but another use for VPNs is to provide you with a secure means of going in the opposite direction. In other words, instead of tunneling your way *out* into the wider internet, we're talking about tunneling *back* into your local network from outside.

Why do this? First, it enables you to access your network as if you were sat at home, giving you access to all your local network resources. But another use for VPNs is to provide you with an alternative—and even more secure—means of accessing your home server. Instead of exposing sensitive services like your self-hosted password manager to the internet through a domain name, for example, you keep them safely 'offline', accessible only through your VPN server.

The great news is that unlike using a VPN to access the outside world, there's no cost involved, because you host the VPN server yourself. Turn the page to find out how to get it up and running with minimal effort.

LET'S BEGIN WITH A RECAP of how a VPN works, and why it's necessary. Data is sent and received over the internet in 'packets'. Not only are these tagged with identifiable information about your location, but unless they're specifically encrypted by whichever service you're using (such as an https website), then their contents can be clearly read by anyone who intercepts them.

To combat this, VPNs create what's known as a 'secure tunnel' to hide your data. This is done by encapsulating every single packet of data within an outer layer that's encrypted using a specific protocol using specially generated cryptographic keys (private and public). Those keys are required by your VPN provider or server to decrypt the data at its destination, ensuring the data can't be read as it travels to and from your devices.

Nate's article in October 2023 focused on how you use a third-party VPN provider to transmit your data—encrypted at source—through its own servers to mask the origin of your traffic. Not only does this ensure your data remains secure, it also allows you to mask your location from both your internet provider and any websites you connect to.

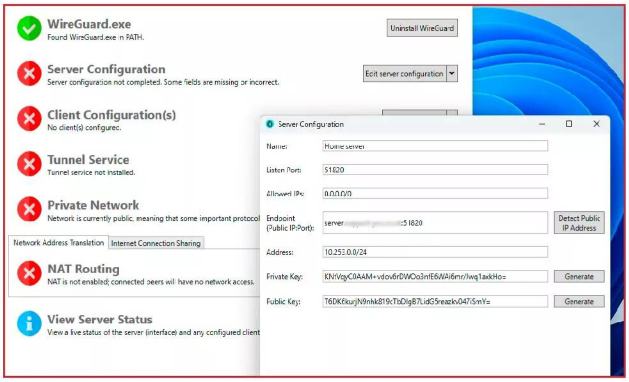
A VPN server setup does the opposite by encrypting data traveling to and from your home network rather than the internet itself. This doesn't simply protect your devices by encrypting the data being sent and received, it also acts as a barrier to anyone else trying to access your home network from outside your home. Unless they have your VPN setup and credentials to hand, there's no way they can connect.

CHOOSE YOUR PROTOCOL

There are multiple VPN encryption protocols out there, but there's only one choice for us: WireGuard (www.wireguard.com). It's the latest standard to emerge, and has become renowned for its performance and ease of use, as well as its rock-solid security.

Like all VPN server setups, WireGuard comprises server and client components. Ideally, the server will be installed on something running 24-7, so it's always available, and you don't need to remember to leave it switched on and connected while you're away. This could be a PC—we'll focus on configuring a Windows PC for the task, but it's also a great fit for a suitably powerful NAS like those offered by QNAP and Synology or our April 2024 Linux-based NAS server build. You might also want to check to see if your router offers a VPN server, either built-in or—in the case of Synology routers—as a separate plug-in. Sadly, the likelihood of WireGuard support is slim, due to its relatively recent appearance. If you want to explore this route, you'll likely have to investigate OpenVPN as an alternative to WireGuard.

You'll find official WireGuard clients for all major platforms. One additional consideration before you begin is how you'll configure your clients to reach your home network. They'll need to know how to reach your home network's public IPv4 or WAN address—this is the address you'll see when you visit www.whatsmyip.com when connected to your home network.


WireGuard.exe
Uninstall WireGuard
Server Configuration
Edit server configuration
Client Configuration(s)
Tunnel Service
Private Network
Network Address Translation
Internet Connection Sharing
NAT Routing
View Server Status
Server Configuration
Detect Public IP Address
Generate
Generate

Found WireGuard.exe in PATH.

Server configuration not completed. Some fields are missing or incorrect.

No client(s) configured.

Tunnel service not installed.

Network is currently public, meaning that some important protocol

NAT is not enabled; connected peers will have no network access.

View a live status of the server (interface) and any configured client

Name: Home server

Listen Port: 51820

Allowed IPs: 0.0.0.0/0

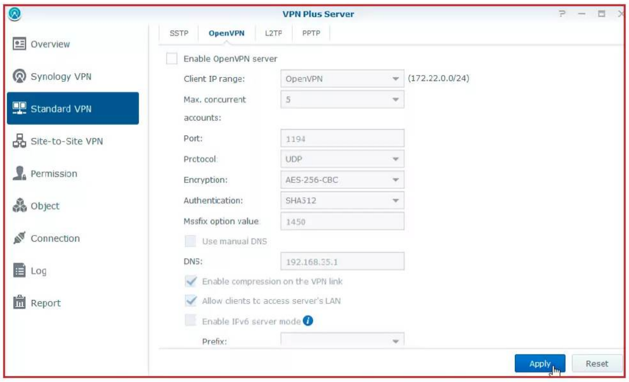
Endpoint (Public IP:Port): server[redacted]:51820

Address: 10.253.0.0/24

Private Key: KNtVqyC0AAM+vdov6rDWOo3nfE6WAi6mr/Jwq1axkHo=

Public Key: T6DK6kurjN9nhk819cTbDlgB7LidG5reazkv047iSmY=

WS4W (WireGuard Server for Windows) makes setup easy.


VPN Plus Server
Overview
Synology VPN
Standard VPN
Site-to-Site VPN
Permission
Object
Connection
Log
Report
SSTP
OpenVPN
L2TP
PPTP
Apply
Reset

☐ Enable OpenVPN server

Client IP range: OpenVPN (172.22.0.0/24)

Max. concurrent accounts: 5

Port: 1194

Protocol: UDP

Encryption: AES-256-CBC

Authentication: SHA512

Mssfix option value: 1450

☐ Use manual DNS

DNS: 192.168.35.1

☑ Enable compression on the VPN link

☑ Allow clients to access server's LAN

☐ Enable IPv6 server mode

Prefix:

Most router-based VPN servers support OpenVPN, but not WireGuard.

The problem with relying on this WAN address is that in most cases, it changes over time (such as when you reboot your router). When this happens, you'll be unable to connect to your VPN until you update your settings. The simplest workaround is to utilize your own domain or a free dynamic domain service that's configured to point to your WAN address—see the box for details.

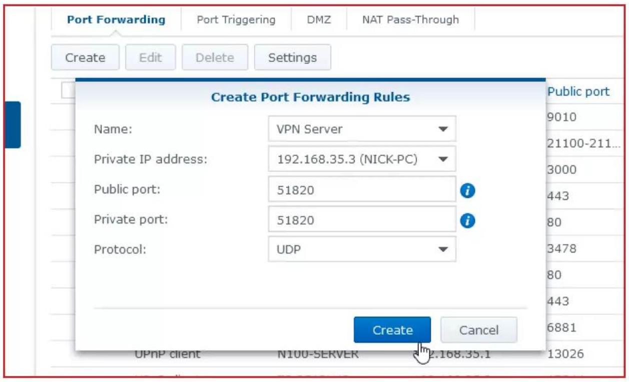
INSTALL IN WINDOWS

There are several ways to install a WireGuard server, but what could still be a tricky process to follow manually is made far simpler by the existence of custom-built 'easy' options. If you plan to install it on your home NAS server, check the box for an implementation involving Docker or Podman. If you're happy to install it on your Windows PC—which needs to be on and connected when you're away from home—then you'll be using a free tool called Wg Server for Windows (WS4W).

WS4W keeps things as simple as possible by automating all of the steps required. Head over to https://github.com/micahmo/WgServerforWindows and download the latest release. Double-click the setup file and follow the prompts to install WS4W with the default settings. You may also be prompted to install the .NET Core Desktop Runtime—do so.

Once done, leave 'Launch Wg Server for Windows' checked, and click Finish. A new dialog will open with a list of steps to follow. First, click 'Download and install WireGuard'. When complete, WireGuard will open its own window, inviting you to add a tunnel. Ignore this, and instead click 'Edit server configuration' in the main WS4W window to open a separate dialog.

Start by giving your server a name (such as 'Home network'). Leave the listen port set at 51820, but before going further, open your router's configuration utility and create a port forwarding


Port Forwarding
Port Triggering
DMZ
NAT Pass-Through
Create
Edit
Delete
Settings
Create Port Forwarding Rules
Create
Cancel
Public port
9010
21100-211...
3000
443
80
3478
80
443
6881
13026
UPnP client
N100-SERVER
.168.35.1

Name: VPN Server

Private IP address: 192.168.35.3 (NICK-PC)

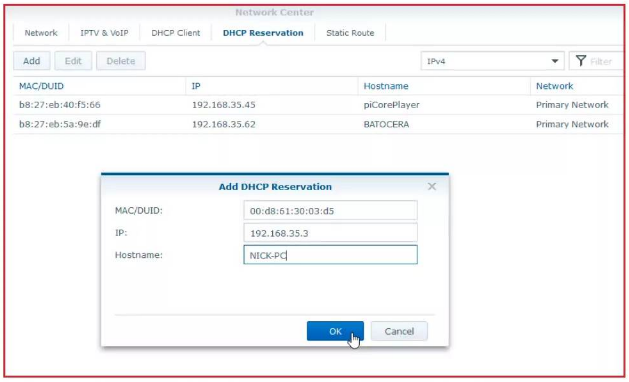
Public port: 51820

Private port: 51820

Protocol: UDP

Forward port 51820 to the computer hosting your WireGuard server.

© WIREGUARD SERVER/MICROSOFT



MAC/DUID	IP	Hostname	Network
b8:27:eb:40:f5:66	192.168.35.45	piCorePlayer	Primary Network
b8:27:eb:5a:9e:df	192.168.35.62	BATOCERA	Primary Network

Add DHCP Reservation

MAC/DUID: 00:d8:61:30:03:d5

IP: 192.168.35.3

Hostname: NICK-PC

Use DHCP reservation if your server has no static IP.

rule to redirect traffic on port 51820 (UDP only) to your PC's IP address. Your PC's IP address should be static, so it never changes. If it's assigned by your router via DHCP, check your router's configuration utility for a DHCP Reservation section, where you can 'pin' a single IP address to a specific device.

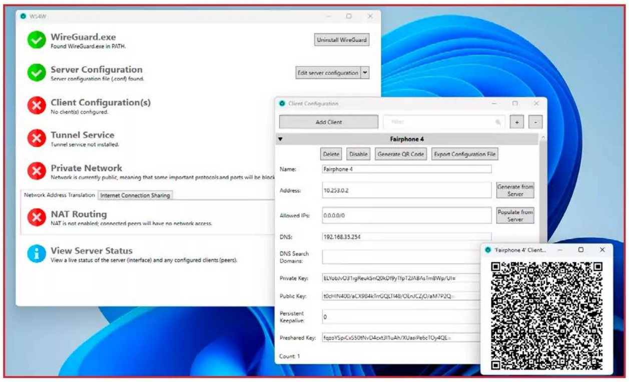
Once done, focus on the Endpoint field. If your ISP has assigned you a never-changing static IP address, click 'Detect Public IP Address' to let the field fill automatically. If not, enter your domain or hostname so it reads something like 'domain.name:51820'.

Below this is the Address field, which refers to WireGuard's own DHCP server, which is used to assign an internal IP address to your client. By default, it uses 10.253.x.x to avoid potential clashes with addresses assigned by your router. The good news is that WireGuard routes traffic from this subnet to your main subnet (typically 192.168.x.y) so it all works seamlessly, ensuring you can access shared folders and other network resources. With this in mind, leave it as it is.

Finally, click Generate next to Private Key, and then again next to Public Key. This generates the all-important keys your client will need to possess to be allowed access to your network via the VPN. These can be easily regenerated as required from here, but you may want to note them down somewhere, such as in your password manager. Finish the server configuration by clicking Save. The dialog will vanish, and after a short pause, a green tick will indicate that the server is now configured.

CONFIGURE CLIENT CONFIGURATIONS

One of the strengths of your VPN server is that you control how many devices can connect to it at any one time. This is done by creating individual client configurations for each connection. This means that devices can only connect through one of these configurations. A single configuration can be shared across multiple devices, but only one device can use that configuration at



WireGuard.exe
Found WireGuard.exe in PATH.

Server Configuration
Server configuration file (.conf) found.

Client Configuration(s)
No client(s) configured.

Tunnel Service
Tunnel service not installed.

Private Network
Network is currently public, meaning that some important protocols and ports will be block

NAT Routing
NAT is not enabled; connected peers will have no network access.

View Server Status
View a live status of the server (interface) and any configured clients (peers).

Fairphone 4

Name: Fairphone 4

Address: 10.253.0.2

Allowed IPs: 0.0.0.0/0

DNS: 192.168.35.254

DNS Search Domains:

Private Key: ELYobJvO31rgReukSnQ0kDf9yTfpT2JABAsTm8Wp/UI=

Public Key: t0cHIN400/aCX9B4kTrrGQLTI48/OEnJCZjO/aM7P2Q=

Persistent Keepalive: 0

Preshared Key: fqzoYSpiCxS50tNvD4cxt3l1uAh/XUasiPe6cTOy4QE=

Count: 1

Once set up, generate a QR code or config file for your client device.

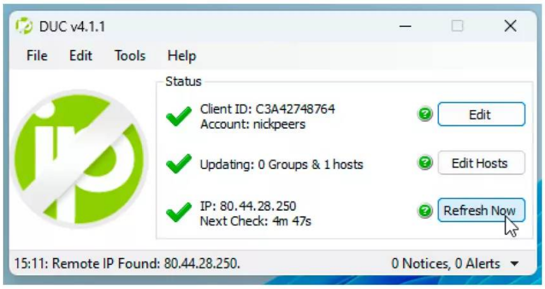
SET UP DOMAIN FORWARDING

The simplest way to ensure that you can always reach your home VPN server is to connect through a domain that's permanently redirecting to your home network's WAN IP address. This requires two elements: the domain itself, of course, but also a dynamic DNS client that can detect when your WAN IP address changes and inform your domain provider of the new address, so people are seamlessly redirected to the correct location.

If you already have a domain name and DDNS client set up to direct traffic to your server—such as Vaultwarden, Motion, Jellyfin, or one of the other many server projects we've covered in recent years—then all the hard work is done. Just enter that domain into the Endpoint field in Wg Server for Windows, or use it for the WG_HOST variable in the WireGuard Easy container. As soon as you set up your router to forward port 51820 to the PC running WireGuard, everything is in place for your VPN server to work seamlessly.

If you don't have anything pointing to your WAN IP, you have a choice: if you own a domain, simply set up a subdomain within your domain provider's web interface to point to it; if not, take advantage of a free hostname from the likes of No-IP (www.no-ip.com). In both cases, setting up the subdomain or hostname is only half the story—you also need to install and configure a dynamic DNS client on any device on your network to ensure that when your WAN IP address changes, your hostname or subdomain is updated to point to the new address.

You have several choices here—we use LinuxServer's ddclient container (https://docs.linuxserver.io/images/docker-ddclient), but check with your domain provider to see if it offers a dedicated Windows app for the job—if you use No-IP, try its own DUC client (www.noip.com/download?page=win), for example.



Client ID: C3A42748764
Account: nickpeers

Updating: 0 Groups & 1 hosts

IP: 80.44.28.250
Next Check: 4m 47s

15:11: Remote IP Found: 80.44.28.250.

0 Notices, 0 Alerts

Check your domain provider for a dynamic update client.

any one time. That might work if you want to restrict the number of connections to your network at any one time for performance reasons, but if not, simply create separate configurations for each device you plan to connect with.

Click the 'Configure client(s)' button to start. This opens a new dialog—click 'Add Client' to set up your first configuration. Start with a descriptive name—typically the device you plan to connect with. Click 'Generate from Server' next to the Address field to assign one of the IP addresses from your VPN server's own pool.

By default, WireGuard assigns Google (8.8.8.8) and Cloudflare (1.1.1.1) DNS servers to your connected client. You can change this if you wish—if you followed our Pi-hole guide from the January 2024 issue, for example, you can set that as your DNS server.

Finally, you'll be prompted to generate more keys: Private, Public, and Preshared in this case. Preshared are optional, but advised for security, as you'll want to share these with the client. Click Save when done to return to the main program window.

To set up your first client, switch to the device you want to use remotely and install the required app—visit www.wireguard.com/install for links and instructions for Windows, macOS, Linux, Android, and iOS. Once installed, open the app, where you'll be prompted to add a tunnel. Click or tap +—you'll see options to import files, scan from QR code, or create from scratch.

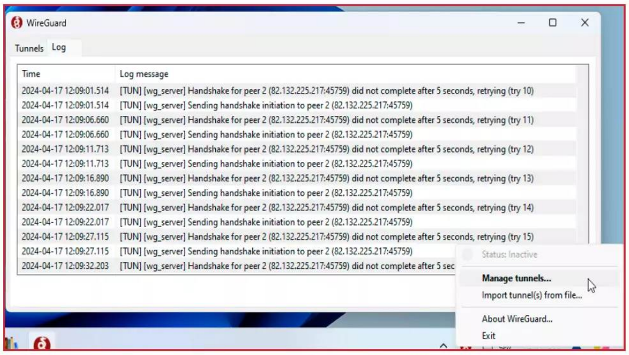
The file and QR code options are the simplest paths to follow. Switch back to WS4W and click 'Configure client(s)' to access your configuration. You'll see two buttons offering to generate a QR code or export a configuration file. If you're connecting a device with built-in webcam, the QR code is the obvious option—when it appears on your PC's display, use your device's webcam to scan it in through the WireGuard client app. When prompted, give your tunnel a name and click 'Create Tunnel'.

The new connection will appear in the app—tap to expand it. You should see it's successfully replicated everything it needs to connect to your home network. You can now close the 'Client Configuration' dialog on your PC and click 'Install tunnel service'.

TEST CONNECTION

Once the tunnel service is running, test your connection. Open the WireGuard client and flick the switch on. Tap OK if prompted to create the VPN connection. Now, click the View button on the main WS4W screen to open a new window that should hopefully confirm that the connection is both live and your client is connected to it. Congratulations—the basic connection is complete!

Now, it's time to finish the setup process. Right now, although your client can connect to your VPN, it has no access to your network, nor can it connect to the internet. WS4W gives you a choice of connection protocols—if you want to use your VPN server through your home connection's IP address, switch to the Internet Connection Sharing tab, and click both buttons ('Enable Internet Sharing' and Enable).



```
Time                     Log message
2024-04-17 12:09:01.514  [TUN] [wg_server] Handshake for peer 2 (82.132.225.217:45759) did not complete after 5 seconds, retrying (try 10)
2024-04-17 12:09:01.514  [TUN] [wg_server] Sending handshake initiation to peer 2 (82.132.225.217:45759)
2024-04-17 12:09:06.660  [TUN] [wg_server] Handshake for peer 2 (82.132.225.217:45759) did not complete after 5 seconds, retrying (try 11)
2024-04-17 12:09:06.660  [TUN] [wg_server] Sending handshake initiation to peer 2 (82.132.225.217:45759)
2024-04-17 12:09:11.713  [TUN] [wg_server] Handshake for peer 2 (82.132.225.217:45759) did not complete after 5 seconds, retrying (try 12)
2024-04-17 12:09:11.713  [TUN] [wg_server] Sending handshake initiation to peer 2 (82.132.225.217:45759)
2024-04-17 12:09:16.890  [TUN] [wg_server] Handshake for peer 2 (82.132.225.217:45759) did not complete after 5 seconds, retrying (try 13)
2024-04-17 12:09:16.890  [TUN] [wg_server] Sending handshake initiation to peer 2 (82.132.225.217:45759)
2024-04-17 12:09:22.017  [TUN] [wg_server] Handshake for peer 2 (82.132.225.217:45759) did not complete after 5 seconds, retrying (try 14)
2024-04-17 12:09:22.017  [TUN] [wg_server] Sending handshake initiation to peer 2 (82.132.225.217:45759)
2024-04-17 12:09:27.115  [TUN] [wg_server] Handshake for peer 2 (82.132.225.217:45759) did not complete after 5 seconds, retrying (try 15)
2024-04-17 12:09:27.115  [TUN] [wg_server] Sending handshake initiation to peer 2 (82.132.225.217:45759)
2024-04-17 12:09:32.203  [TUN] [wg_server] Handshake for peer 2 (82.132.225.217:45759) did not complete after 5 sec
```

The official WireGuard client provides a log of VPN activity.

© WIREGUARD SERVER/MICROSOFT

INSTALL IN DOCKER OR PODMAN

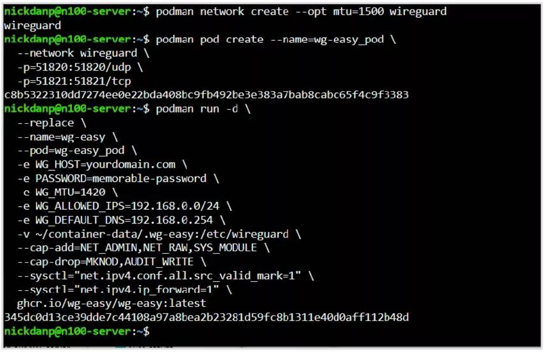
Another way to install WireGuard is as a container following our previous guides to Podman and Docker. The aptly titled WireGuard Easy combines both WireGuard itself with a user-friendly frontend for managing connections through your web browser. Visit https://github.com/wg-easy/wg-easy to find out more about the tool and access detailed instructions if you need them.

If you've followed our lead in switching from Docker to Podman, the good news is that there are dedicated instructions for running WireGuard Easy as a rootless Podman container on the app's wiki (https://github.com/wg-easy/wg-easy/wiki - click 'Using WireGuard Easy with rootless Podman'). On our Debian server, we needed to create a podman network with MTU of 1500, and then we adapted the script, as shown in the screenshot.

After the container is up and running, access the web interface through your web browser at http://192.168.x.y:51821. Enter the admin password you added to the Podman script to log into the web interface.

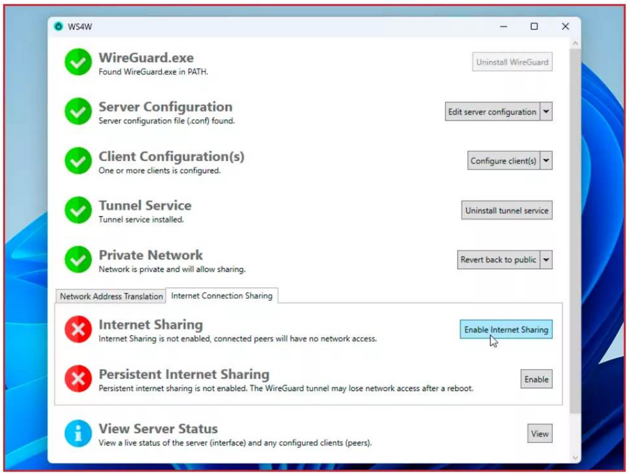
You'll be shown a basic screen inviting you to set up your clients—click '+ New Client' to do so. The client configuration process is even easier than WS4W's—just give it a suitably descriptive name, and you're good to go. It'll be assigned an IP address and all you need to do is set up your client using the links to either view a QR code, or download the configuration file.

The web interface also shows when a client is connected and shows the amount of data being uploaded and downloaded. There are fewer configuration options than those offered by Wg Server—these should be defined in the Podman script when creating the container. You can also tweak settings like the DNS server from the WireGuard client, if you need to.



```
nickdanp@n100-server:~$ podman network create --opt mtu=1500 wireguard
wireguard
nickdanp@n100-server:~$ podman pod create --name=wg-easy_pod \
  --network wireguard \
  -p=51820:51820/udp \
  -p=51821:51821/tcp
c8b5322310dd7274ee0e22bda408bc9fb492be3e383a7bab8cabc65f4c9f3383
nickdanp@n100-server:~$ podman run -d \
  --replace \
  --name=wg-easy \
  --pod=wg-easy_pod \
  -e WG_HOST=yourdomain.com \
  -e PASSWORD=memorable-password \
   c WG_MTU=1420 \
  -e WG_ALLOWED_IPS=192.168.0.0/24 \
  -e WG_DEFAULT_DNS=192.168.0.254 \
  -v ~/container-data/.wg-easy:/etc/wireguard \
  --cap-add=NET_ADMIN,NET_RAW,SYS_MODULE \
  --cap-drop=MKNOD,AUDIT_WRITE \
  --sysctl="net.ipv4.conf.all.src_valid_mark=1" \
  --sysctl="net.ipv4.ip_forward=1" \
  ghcr.io/wg-easy/wg-easy:latest
345dc0d13ce39dde7c44108a97a8bea2b23281d59fc8b1311e40d0aff112b48d
nickdanp@n100-server:~$
```

These steps got WireGuard up and running on our NAS.


WS4W

WireGuard.exe
Found WireGuard.exe in PATH.

Server Configuration
Server configuration file (.conf) found.

Client Configuration(s)
One or more clients is configured.

Tunnel Service
Tunnel service installed.

Private Network
Network is private and will allow sharing.

Internet Sharing
Internet Sharing is not enabled, connected peers will have no network access.

Persistent Internet Sharing
Persistent internet sharing is not enabled. The WireGuard tunnel may lose network access after a reboot.

View Server Status
View a live status of the server (interface) and any configured clients (peers).

Uninstall WireGuard
Edit server configuration
Configure client(s)
Uninstall tunnel service
Revert back to public
Network Address Translation
Internet Connection Sharing
Enable Internet Sharing
Enable
View

You can configure your VPN to provide secure internet access.

To open your network to your VPN clients, stay on the 'Network Address Translation' tab and click 'Enable NAT'. This gives your clients access to both your network and a secure path to the internet. Windows makes your VPN network public for security reasons. Click 'Make private' to enable network sharing.

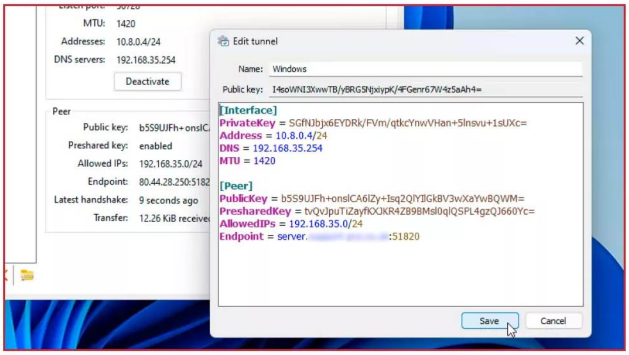
With everything marked green in WS4W, your server configuration is practically complete. You can perform further tweaks and set up additional client configurations, or close the window—your WireGuard connection remains active (see the WireGuard icon in the Taskbar's Notification area; it'll erroneously claim to be inactive, but open the main window and switch to the Log tab, where you'll see the wg_server tunnel is active and working as it should).

Should you need to change things further, type 'wg' into the Search box to reveal the Wg Server for Windows shortcut.

FURTHER CLIENT CONFIGURATION

You can now dial into your home network from any configured clients, effectively placing them within the network. That's great when working with your laptop or Chromebook, but when you're connecting through your mobile, you might prefer a hybrid approach to counter any performance penalties.

That's possible thanks to the mobile client, which allows you to choose exactly which apps connect through your VPN server and which ones use its native connection. To do this on an Android phone, for example, tap the connection to expand it, followed by the pencil icon to edit its configuration. You'll see an 'All Applications' link—tap this to choose whether to exclude specific apps or include specific apps only depending on your preferences. ⏻


MTU: 1420
Addresses: 10.8.0.4/24
DNS servers: 192.168.35.254

Peer
Public key: b5S9UJFh+onslC
Preshared key: enabled
Allowed IPs: 192.168.35.0/24
Endpoint: 80.44.28.250:5182
Latest handshake: 9 seconds ago
Transfer: 12.26 KiB receive

Edit tunnel
Name: Windows
Public key: I4soWNI3XwwTB/yBRG5NjxiypK/4FGenr67W4z5aAh4=

```
[Interface]
PrivateKey = SGfNJbjx6EYDRk/FVm/qtkcYnwVHan+5lnsvu+1sUXc=
Address = 10.8.0.4/24
DNS = 192.168.35.254
MTU = 1420

[Peer]
PublicKey = b5S9UJFh+onslCA6lZy+Isq2QlYIlGkBV3wXaYwBQWM=
PresharedKey = tvQvJpuTiZayfKXJKR4ZB9BMsl0qlQSPL4gzQJ660Yc=
AllowedIPs = 192.168.35.0/24
Endpoint = server.[redacted]:51820
```

Deactivate
Save
Cancel

Some VPN settings can be tweaked or altered from the client itself.

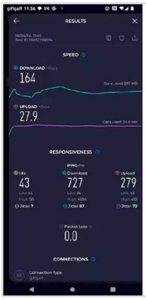
HOME SERVER VERSUS VPN PROVIDER

The main reason to set up this home server VPN is to allow you to dial into your home network from anywhere in the world without compromising your security. However, your VPN server does give you some of the same functionality of a third-party VPN provider, too. The most useful is the fact that when logged in, you'll be accessing the internet through your home connection. This allows you to connect securely to the internet through insecure networks like public Wi-Fi hotspots.

A second benefit is that when you're abroad, connecting through your VPN server allows you to bypass certain geo-restrictions in the country you're in, allowing you to—for example—access domestic streaming services back home, all without having to pay a third-party provider for the privilege.

That said, there are caveats. You can't use your VPN server to anonymize your internet connection, as you can with a VPN provider. That's because all your traffic originates from your home internet connection, making it easy to identify you as the source. You also can't use it to bypass geo-restrictions to access content from other countries, such as the BBC's UK iPlayer service.

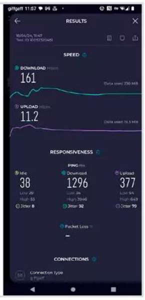
There's also performance. VPNs require system resources to encrypt and decrypt data before and after transmission, while the need to re-route data through your home network can also be a drag, particularly if your home internet connection isn't the quickest. The issue can be further compounded by the amount of traffic from others using your home network or trying to connect through your VPN at the same time. If you don't need the extra features offered by third-party VPNs, your WireGuard server could be the only VPN service you need.


giffgaff 11:56
RESULTS
SPEED
DOWNLOAD
164
UPLOAD
27.9
RESPONSIVENESS
PING ms
Idle
43
Jitter 7
Download
727
Jitter 87
Upload
279
Jitter 73
Packet Loss
0.0
CONNECTIONS
Connection Type

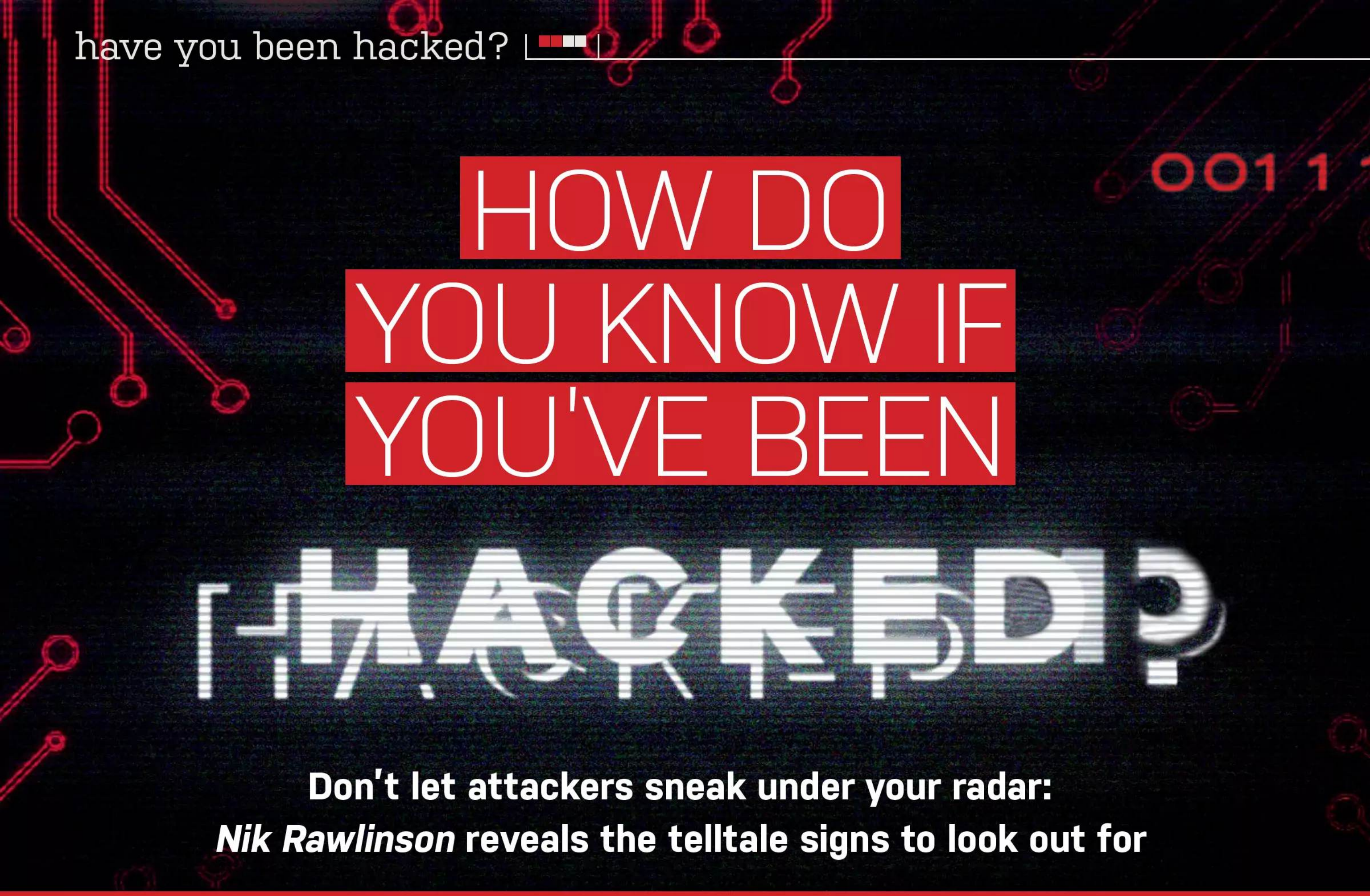
These tests were performed on a Fairphone 4 with 5G connection.

The native 5G connection speeds are on the left, while the speeds on the right were attained when our VPN server was activated.

The key effects were on upload speeds and responsiveness (lower scores are better). Despite this, the WireGuard protocol appears to be extremely efficient, justifying our decision to use it as the base for our VPN server.


giffgaff 11:57
RESULTS
SPEED
DOWNLOAD
161
UPLOAD
11.2
RESPONSIVENESS
PING ms
Idle
38
Jitter 8
Download
1296
Jitter 92
Upload
377
Jitter 79
Packet Loss
–
CONNECTIONS
Connection Type

Use Speedtest to benchmark your devices with and without the VPN enabled.



HOW DO YOU KNOW IF YOU'VE BEEN HACKED?

Don't let attackers sneak under your radar: *Nik Rawlinson* reveals the telltale signs to look out for

CYBERATTACKS don't look like you might expect—and they certainly don't look like they do in the movies. If your security is compromised, you probably won't see a big flashing sign saying 'YOU HAVE BEEN HACKED', or weird skull-and-crossbones graphics filling your display.

On the contrary, modern attackers lay low. The era when hackers just wanted to attract attention and cause chaos has long gone—today, they more likely want to use your computer for mining cryptocurrency, or as a staging point for launching anonymous attacks on remote targets. Or, of course, they may intend to quietly encrypt your personal files, with a view to demanding a ransom for the decryption key. Whatever the goal, it's in their interest to be as discreet as possible, and not to tip you off that you've been compromised, at least until their dirty work is done.

Those scenarios apply equally in business environments, along with the additional concern of digital espionage. For a company, the first indication of an intrusion might look like nothing more than a strange coincidence—a rival beating you to market with a product that looks a lot like your own, perhaps, or pursuing contacts and deals in a way that stymies your commercial strategy. It could be sheer bad luck, or it could be that someone has been spying on your confidential plans.

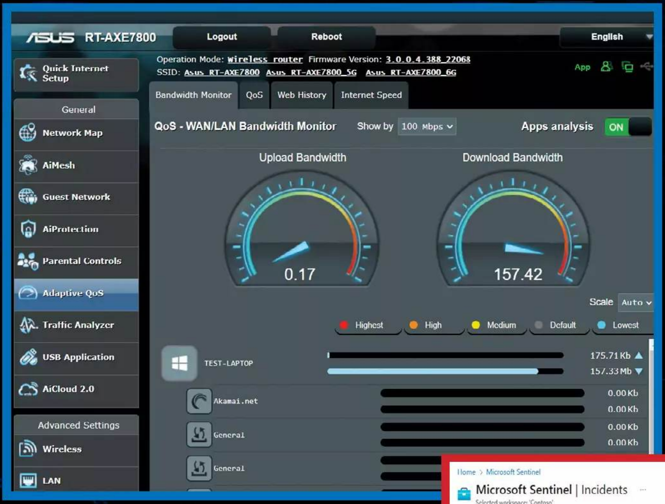
Whatever their intention, attackers know to bide their time, quietly siphoning off your resources or learning about your business. According to figures from Sophos, the average 'dwell time'—the time an attacker had access to compromised systems before being discovered—was eight days in 2023. That's an improvement on the average of ten days in 2022 and 15 days in 2021, but it's still an alarming statistic. Here are some recommendations that can help you identify and resolve attacks quickly—and prevent them happening in the first place.

COMMON THREAT VECTORS

Computer security is an area where prevention is certainly better than cure. Many hack attacks are enabled by weak passwords, compromised credentials, brute-force attacks, or misconfigured network hardware, so it goes without saying that you should take steps to close off all of these avenues. In business, each of these potential vectors of attack will already be on an administrator's watchlist, and companies should be enforcing policies to ensure effective credential hygiene. If you're working from home, or just using your own computer for everyday internet duties, you'll need to take matters into your own hands.

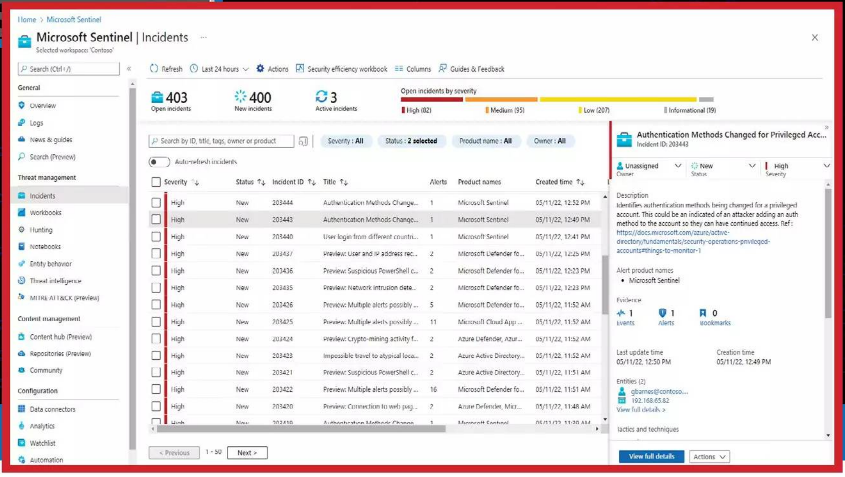
To sharpen up your passwords, note that length can be more effective than complexity. Common 'complications', such as using digits in place of letters, are well understood, and brute-force attacks will breeze through them. However, each additional character in your password significantly increases the length of time it will take to crack. The usual advice about not recycling passwords or using personally identifiable information still applies.

Remember, too, that no matter how strong your passwords are, they could be exposed by an attack on the services you use them to log into. Alternatively, you could be tricked into revealing them by phishing attacks or other types of social engineering. These are even bigger concerns for businesses, as


RT-AXE7800
Logout
Reboot
English
Quick Internet Setup
Operation Mode: Wireless router Firmware Version: 3.0.0.4.388_22068
SSID: Asus_RT-AXE7800 Asus_RT-AXE7800_5G Asus_RT-AXE7800_6G
General
Network Map
AiMesh
Guest Network
AiProtection
Parental Controls
Adaptive QoS
Traffic Analyzer
USB Application
AiCloud 2.0
Advanced Settings
Wireless
LAN
Bandwidth Monitor
QoS
Web History
Internet Speed
QoS - WAN/LAN Bandwidth Monitor
Show by 100 Mbps
Apps analysis ON
Upload Bandwidth
Download Bandwidth
0.17
157.42
Scale Auto
Highest
High
Medium
Default
Lowest
TEST-LAPTOP
175.71 Kb
157.33 Mb
Akamai.net
General
General
0.00 Kb
0.00 Kb
0.00 Kb
0.00 Kb

Most routers feature a bandwidth monitor so you can see if there has been any unusual network activity.

Microsoft Sentinel analyzes data from a wide range of sources to identify potential security incidents.


Home > Microsoft Sentinel
Microsoft Sentinel | Incidents
Refresh
Last 24 hours
Actions
Security efficiency workbook
Columns
Guides & Feedback
403 Open incidents
400 New incidents
3 Active incidents
Open incidents by severity
High (82)
Medium (95)
Low (207)
Informational (19)
General
Overview
Logs
News & guides
Search (Preview)
Threat management
Incidents
Workbooks
Hunting
Notebooks
Entity behavior
Threat intelligence
MITRE ATT&CK (Preview)
Content management
Content hub (Preview)
Repositories (Preview)
Community
Configuration
Data connectors
Analytics
Watchlist
Automation
Severity
Status
Incident ID
Title
Alerts
Product names
Created time
Authentication Methods Changed for Privileged Acc...
Incident ID: 203443
Unassigned
New
High
View full details
Actions
< Previous
Next >

the consequences of a malicious actor gaining access to company resources could be enormous.

To reduce the risk, 2FA and biometrics make it harder for untrusted outsiders to get into your systems. It's also an established rule of IT administration that users (and services) should only have access to the resources and privileges they need. This way, if someone steals a username and password, there's a limit to how much damage they can do. You can apply that principle to your home network, as well as in the office.

This approach also helps prevent another danger in the workplace: insider threats, such as when a member of staff illicitly takes copies of sensitive data that can be used for competition or extortion. You might imagine that such attacks are rare, but they're a growing problem. Analyst Proofpoint reports that in 2022, the cost to business of insider security threats increased by 62 percent in retail organizations, and 47 percent in financial services. Response times, meanwhile, are slipping—it now takes 85 days to contain an insider threat, compared to an average of 77 days just two years ago. Managers can minimize the risk of such attacks with a coordinated approach across teams and departments, ensuring workers know how to spot and report suspicious behavior or security loopholes.

Whether you're managing a personal Wi-Fi router or a huge corporate LAN, it's important to ensure that all devices on your network are kept appropriately patched and updated. A report from Tenable Research revealed that of the five most widespread cyberattacks in 2022, four relied on 'zero-day' exploits that were patched on the same date as they were first observed in the wild (see tinyurl.com/356research). In other words, most infections could have been avoided if individuals and IT managers had kept their protection up to date.

Another practical measure you can take is to enable MAC address filtering on your router to ensure that only known devices can connect to your network. This doesn't give you perfect protection, as addresses can be spoofed and bypassed, but it will almost certainly keep casual interlopers from connecting to your network. Similarly, it's a good idea to disable remote management on your router so that settings can only be changed from inside your network.

SIEM AND SOAR

Even if you religiously follow best-practice security measures, your network could still be compromised via means outside of your control. That's why it's important to recognize an intrusion as soon as possible, so you can neutralize it, hopefully before it's able to do any damage.

For home users, the signs of a compromise can be subtle. You may notice a change in the performance of your computer or network, or requesters that you haven't seen before (see 'Has my home been hacked?' overleaf). Businesses can spot problems via network monitoring—the catch here is that a fleet of tens or hundreds of computers will generate a lot of data—far more than an in-house security team can possibly analyze by hand. This is where SIM, SEM, and SOAR tools come in.

SIM stands for Security Information Management, and refers to the long-term process of collecting usage data for analysis. This data then feeds into SEM (Security Event Management), which identifies patterns within the data. Combined, these two approaches become SIEM (Security Information and Event Management), which encompasses an overarching workflow of gathering, analyzing, and acting upon data.

As the US National Institute of Standards and Technology explains, SIEM "provides the ability to gather security data from information system components and present that data as actionable information via a single interface". An effective SIEM solution

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can spot the signs of an intrusion or malicious interference far more quickly than a human could.

Finally, we come to SOAR (Security Orchestration, Automation, and Response). This actively responds to intelligence from the SIEM layer and other inputs, such as IoT alerts and regular security scans. That might mean blocking types of access, or locking down some resources. SOAR workflows are defined in advance, so security teams will need to remain vigilant, pay attention to the output of their SIEM tools, and define the workflows that SOAR should take. Once set up, these workflows are ready for immediate use, reducing dwell time and minimizing risk to a company's data, systems, and reputation.

SIEM and SOAR systems are increasingly making use of machine learning to identify hidden patterns within big data. This is particularly relevant in the case of UEBA (User and Entity Behavior Analytics), which monitors actual activity and spots when a user, server, or any network device starts doing something out of the ordinary. As IBM describes it, UEBA "is effective at identifying insider threats—malicious insiders or hackers who use compromised insider credentials—that can elude other security tools because they mimic authorized network traffic" (see tinyurl.com/356ibm).

DEVISE A PLAN OF RESPONSE

Once an intrusion is detected, time is of the essence, so whether you're working with a single computer or an office full of devices, plan possible scenarios and responses in advance. In fact, being prepared is potentially more important for home workers, who typically don't have specialist IT support staff on hand, nor conveniences such as backup archives and spare hardware. Think about how you'd stay safe and

HAS MY HOME BEEN HACKED?

For a home network, advanced measures such as SIEM, SOAR, and UEBA aren't practical, but there are some red flags you can look out for as indications that you may have been compromised.

1. SUDDENLY SLUGGISH PERFORMANCE

This can be caused by something unaccounted-for eating up your computer's resources. A continually running fan, a laptop that gets unusually hot or a battery that conks out in double-quick time can all also be clues that a rogue process is working the processor hard.

2. AN UNUSUAL SPIKE IN NETWORK TRAFFIC

This is another sign that something is amiss; it could be caused by someone exfiltrating your data, using your internet link to fire off spam or initiating a flood of connections for a DDoS attack. If you have a fast internet service, you might not notice an unusual load, but many routers include traffic monitoring and management features that can help.

3. NON-FUNCTIONING PASSWORDS

When hackers gain access to a service or router, the first thing they'll often do is change the password to prevent you from checking up on their activity and kicking them out. If you find you're unexpectedly locked out of an account, take action sooner rather than later.

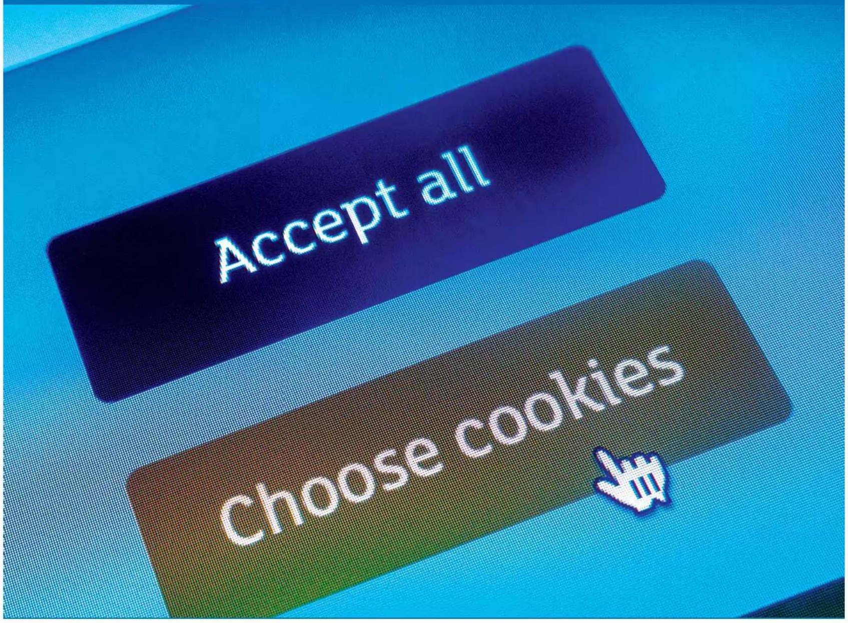
4. ODD POP-UPS

We said that modern infections like to lie low, but there's a particular species of malware that does the opposite, throwing up alarms and alerts that warn you of computer issues or (ironically) a virus infection. You'll then be urged to buy a particular piece of software or visit a website to 'fix the problem'. Needless to say, it's a scam.

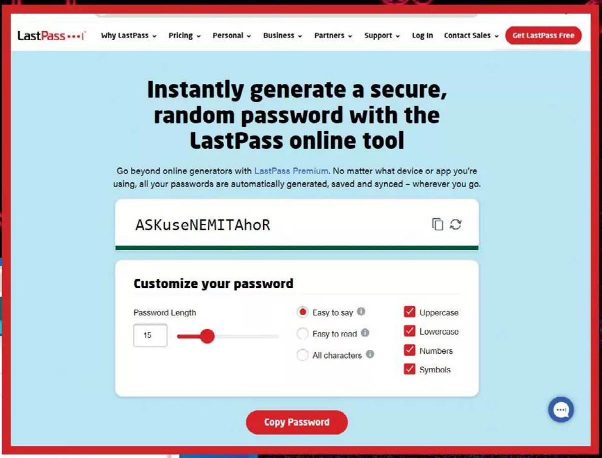
5. UNEXPECTED SEARCH RESULTS OR WEB CONTENT

A router hack or a devious piece of malware can hijack your traffic, sending you to unfamiliar sites, or bogus phishing copies of legitimate ones. You could easily be tricked into entering personal or business-critical information, such as webmail or cloud login details. These sites can also install further malware on your machine.

In all cases, if you think you might have been breached, you should follow the usual security procedures. Ensure the OS, applications, and firmware are up to date on all your devices, perform a thorough antivirus scan, check system and network settings, and change any passwords that might have been compromised.



© SEAN GLADWELL/GETTY IMAGES



Instantly generate a secure, random password with the LastPass online tool

Go beyond online generators with LastPass Premium. No matter what device or app you're using, all your passwords are automatically generated, saved and synced – wherever you go.

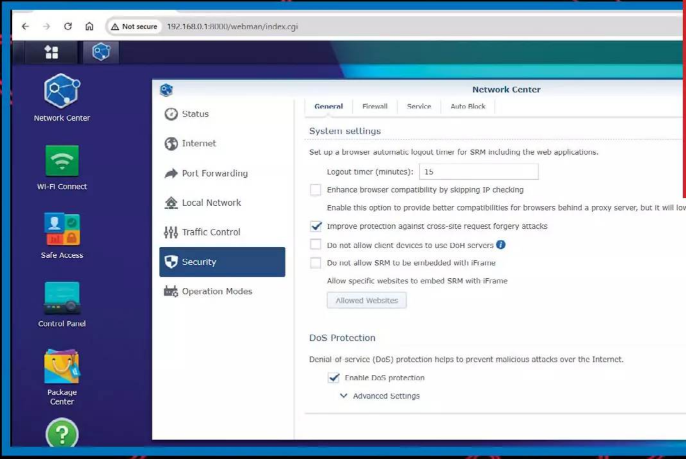
ASKuseNEMITAhoR

Customize your password

Password Length: 15

● Easy to say
○ Easy to read
○ All characters

☑ Uppercase
☑ Lowercase
☑ Numbers
☑ Symbols



Not secure 192.168.0.1:8000/webman/index.cgi

Network Center

System settings

Set up a browser automatic logout timer for SRM including the web applications.

Logout timer (minutes): 15

☐ Enhance browser compatibility by skipping IP checking

Enable this option to provide better compatibilities for browsers behind a proxy server, but it will lower the security level.

☑ Improve protection against cross-site request forgery attacks

☐ Do not allow client devices to use DoH servers

☐ Do not allow SRM to be embedded with iFrame

Allow specific websites to embed SRM with iFrame

DoS Protection

Denial of service (DoS) protection helps to prevent malicious attacks over the Internet.

☑ Enable DoS protection

Advanced Settings

ABOVE When it comes to passwords, length can be more effective than complexity.

LEFT Synology's Network Center provides an easy-to-use way of monitoring status and resource usage.

© SYNOLOGY

productive if an attack made your main computer unusable, or if the files stored on it were leaked or encrypted.

Businesses should start by drawing up a list of network assets, both on site and remote. Ensure you know how staff can continue working if you need to deal with an intrusion, or determine whether your best hope of a swift and sure recovery is to temporarily shut down all access and swallow any losses. Don't forget staff who might be working remotely and need to connect to corporate systems. Consider using a central management database to tally users and issued equipment.

As well as figuring out what you need to do, make sure everything is documented. Writing up technical manifests and hypothetical scenarios may feel like a chore, but in an emergency you'll be glad to have a record of your network infrastructure. If you've offloaded your services to a third-party cloud provider, ensure you have network maps of your remote processes, and that you understand how your data is looked after. If an infiltration results in data being lost or leaked, you may be accountable: being able to show that you've taken all reasonable measures to secure your network and data assets won't entirely mitigate the situation, but it will reassure users, clients and the authorities by demonstrating your commitment to security and the responsible handling of third-party data.

The penalties for poor caretaking of personal data have become more significant over recent years, while at the same time, threats are evolving. Whatever scale you're working on, you need to stay abreast of changes in the security landscape. This inevitably involves a cost, be it in terms of research or financial investment, but it will be lower than the cost of a breach, which could involve the loss of irreplaceable data, disruption to your business, and the unquantifiable value of a dented reputation.

NETWORK SAFETY FOR BUSINESSES

For companies seeking professional SIEM and SOAR solutions, Microsoft Sentinel is a cloud-based service that can draw in metrics from a wide range of products published by Microsoft and others. It analyzes all of this data to identify 'incidents', which are multiple instances of matching alerts. This helps deliver an overview of what's happening within the IT estate. After all, a series of disconnected alerts might not mean much if they appear now and then, but together, they can highlight the presence of a threat or network issue. Sentinel isn't limited to Windows, either; data sources can include API output, or logs generated by machines running Linux. Find out more at tinyurl.com/356sentinel.

Another option is Sumo Logic's Cloud SIEM (sumologic.com), which uses a signal-clustering algorithm to automatically group related signals. When a set threshold is reached (by default within a 14-day window), it generates an 'Insight', on the basis of which admins can start investigating. Datadog (datadoghq.com) likewise combines alerts using composite monitors to minimize alert noise. The ability to spot patterns in data more effectively than human operators, and track them over the longer term, can expose telling deviations from the norm that would otherwise be easy to miss.

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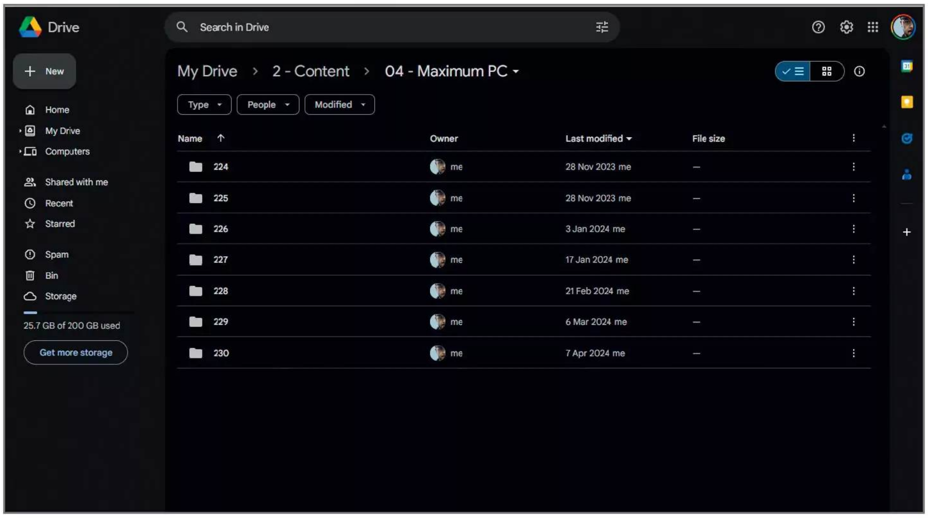
HOW TO

STEP-BY-STEP GUIDES TO IMPROVING YOUR PC

TIP OF THE MONTH



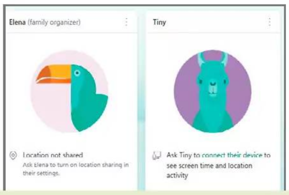
Name	Owner	Last modified	File size
224	me	28 Nov 2023 me	—
225	me	28 Nov 2023 me	—
226	me	3 Jan 2024 me	—
227	me	17 Jan 2024 me	—
228	me	21 Feb 2024 me	—
229	me	6 Mar 2024 me	—
230	me	7 Apr 2024 me	—

GOOGLE DRIVE DARK MODE

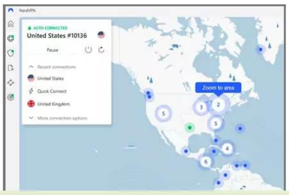
Nobody panic—it's finally happened. Google has implemented a 'Dark mode' for its Google Drive suite on web. To activate it, simply click the settings cog on the drive of your choice, scroll down to 'Appearance', and change it to what mode you'd like. Bear in mind that this only changes the drive file explorer, not the actual documents themselves.

MAKE – USE – CREATE

60
How to use Photoshop's new AI features



64
Using parental controls in Windows 11



68
Prevent browser fingerprinting

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ZAK STOREY
CONTRIBUTOR

MISSING YESTERYEAR

I've been in the tech industry for quite some time—coming up to ten years next year. The older I've gotten, though, the more I'm starting to miss the past.

I've always been into PC gaming, and have long built my own machines, since my mom rewarded me with some cash to build a brand-new gaming PC as a reward for getting into university.

I picked up a Core i5-12500K, Asus P67 Deluxe mobo, 8GB of Corsair RAM, and an MSI GTX 460 Twin Frozr II. I paired that with a power supply inside a Bitfenix Shinobi ATX chassis. II had a 1080p Benq screen, Logitech Z4 speakers, a Logitech G110 keyboard, and a Cooler Master Infero mouse. It had a stock Intel cooler as well, and an HDD from an old rig. I named it Titan.

A year later, AI Suite kicked up an error saying my CPU was too hot, as it had hit 70 C (ha). I quickly Googled a good cooler, and came across a Linus Tech Tips video on the Zalman CNPS11X. From then, I got hooked on the scene, watched and read everything I could, and started building PCs and tinkering with what little I had, building rigs and speccing them up for friends.

A lot has changed since those days, from hardware and software, to friends, family, and life in between. But I still love PC building.

↘ submit your How To project idea to: editor@maximumpc.com

Use Photoshop's new AI features

YOU'LL NEED THIS

PHOTOSHOP CC 25.5 OR LATER

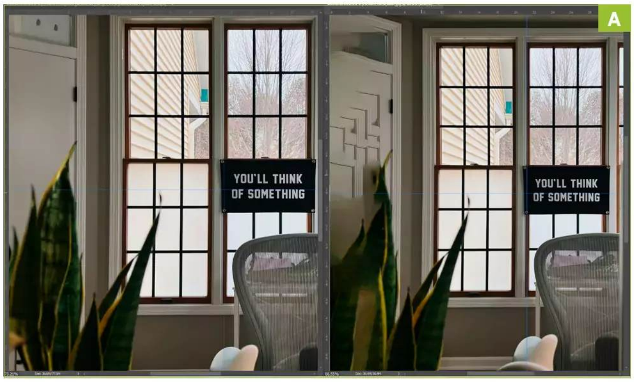
Some images

An internet connection

ADOBE HAS DONE a lot of work to integrate generative AI—a system it calls Firefly—into Photoshop over the past year. The technology has made the jump from the beta version of the app to the mainline release you'll find on Creative Cloud, as well as the web and iPad versions.

The image-editing app's AI capabilities now cover much more than producing uncanny images of people with six fingers and an uncountable number of teeth, but then, that was never Adobe's approach to the tech. It has always taken the position of seeing what neural networks can do for Photoshop without allowing them to become Photoshop, and while the current buzz on social media might be about models such as Sora creating entire videos from scratch, in Photoshop you're expected to use it to enhance an existing image, saving time and effort, but not compromising on your creativity.

As such, while it's possible to open a blank document and generate an image of a PC-strewn office or enormous cup of coffee, AI in Photoshop is better used for things like expanding backgrounds, removing power lines, or adding and moving objects. Some of it is less than intuitive, however, as we shall see. **–IAN EVENDEN**



1 THE TOOLBAR

Generative AI in Photoshop is accessed via a floating toolbar that always seems to be either missing or in the way. It's clunky, but while it's possible to imagine many worse ways of doing it, a more elegant solution seems elusive. We're using version 25.6 of the app, so it's possible things will be refined. You'll need 25.5 or later to use some of the tools in this tutorial.

» Generative AI is also tied to the Properties palette on the right of the interface, from where you can choose between variations of the generated imagery, and the Options palette that's at the top, too. Adobe calls the floating bar the Contextual Task Bar, but we'll call it the floating toolbar so it doesn't get confused with the Windows Taskbar. While attempting to take screenshots for this tutorial, the floating toolbar vanished, and could only be brought back by unchecking and rechecking the Contextual Task Bar option on the Window menu. To avoid this, you can pin the bar in place by clicking the three-dot menu on its right, drag it around by clicking on its left-hand end when it inevitably obscures an important part of your project, or make it go away completely by choosing Hide.

2 GENERATIVE EXPAND

The first generative AI tool we're going to look at is a simple one. For a while, Photoshop users have been able to use Context Aware Fill to help reshape an image, with mixed success—sometimes it produces the ideal result, other times a mess of repeating patterns. Generative Expand improves on Context Aware Fill, especially in detailed scenes at the cost of speed—it takes noticeably more time to process, and you'll be watching a progress bar with useful tips on it for longer, giving time for trips to the coffee machine. Changing an

FIREFLY TRAINING DATA

There has been controversy recently over AI image generators trawling the web for their training data and violating artists' copyright in the process. Adobe says Firefly is trained on licensed content, such as Adobe Stock, and public domain images that aren't covered by copyright. As a result, Firefly is designed to be 'commercially safe'—corporate speak for 'OK for businesses to use legally'.

However, Adobe Stock contributors aren't happy their images are being used in this way, telling VentureBeat that they should have been asked for their consent, though this use is covered by the terms and conditions. Adobe Stock also accepts AI-generated images, something many other stock photo libraries do not, and hosts a PDF on its website with tips for how to optimize your AI images for the library.

Last year, according to a report by PetaPixel, AI images outperformed those taken by human photographers in terms of revenue per image on Adobe Stock, though this was based on early data, and may not be fully representative. The idea that purchasing well-composed and prompted AI images may be better than rolling your own with a Firefly prompt is an interesting one, however.

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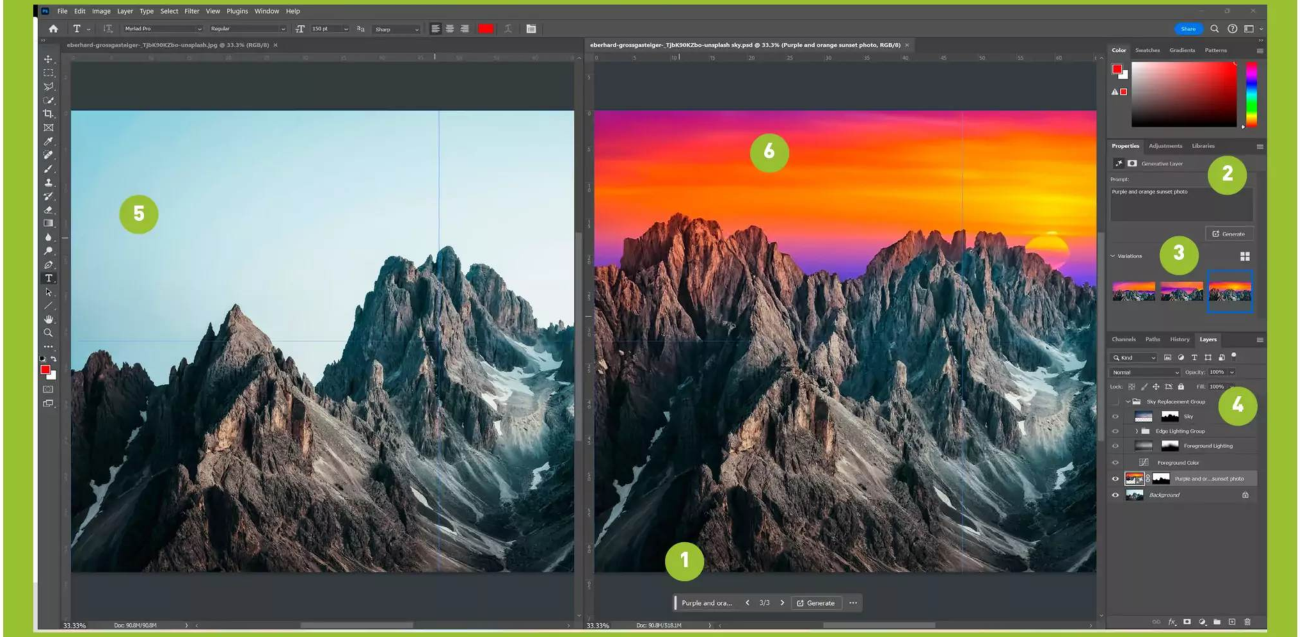
USING AI IN PHOTOSHOP



1. FLOATING TOOLBAR
Here it is, before it pulls another disappearing act. The Generate button here can be pressed without a prompt for simple fills.

2. PROMPT BOX
Over on the Properties panel is a larger version of the floating toolbar, which gives you more space to compose your prompt.

3. VARIATIONS
Photoshop spits out three variations on the prompt or fill you've used, and you can flick through them to see which you like best.

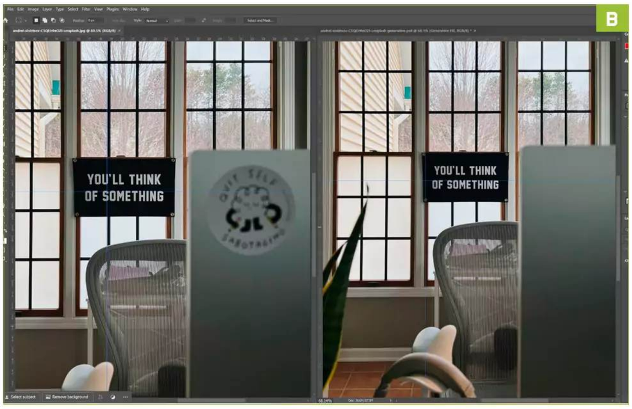
4. LAYERS
The Sky Replacement Group here comes from the Sky Replacement window, and contains image and adjustment layers.

5. ORIGINAL IMAGE
This is what it looked like before we started, with a fairly plain sky behind some mountains. It's by Eberhard Grossgasteiger, who's from Italy.

6. NEWLY GENERATED SKY
Here's the image we've ruined with a generated sky, not the nice blended photo from the Sky Replacement tool. It has added new mountains, too.

image like this is useful for those times you're trying to fit a 3:2 aspect ratio image into a 16:9 hole, or even when you're supplied an image in portrait orientation when you need it to be landscape.

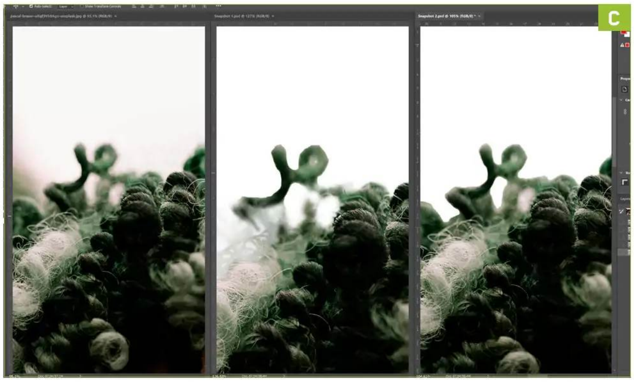
» The way it works is simple. It's built into the Crop tool, so you drag out the familiar box to the required dimensions, even if this means going over the edges and into the blank white nothingness beyond. Instead of choosing Content Aware Fill, pick Generative Expand from the drop-down menu on the Options palette, and click the checkmark to proceed.

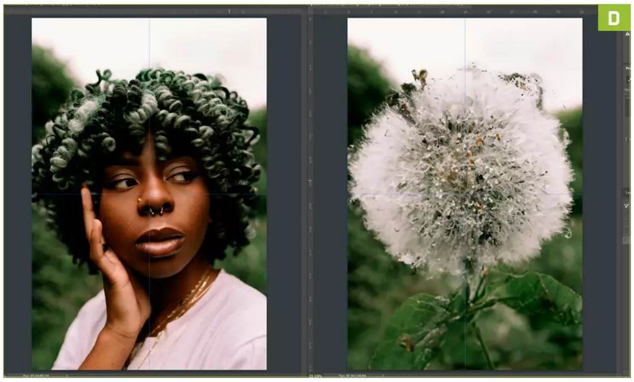


» [Image A] shows the difference between Content Aware and Generative: both images were expanded on the left, but the Content Aware image has repeated the corner of the door where Generative Expand has left it smooth, and the Generative plant (despite being out of focus) has a more realistic look than the green and yellow blur the Content Aware tool has created. It's still not perfect—the top of the door is wonky in both images—but it would be much quicker to touch that up than to remove the repeated corners.

3 OBJECT REMOVAL

[Image B] is another before-and-after in which we've removed the sticker from the back of what's probably an iMac (the older, thicker model from before they became so thin at the edge you could swing one as an anti-zombie weapon) that says 'Quit self sabotaging'. We don't go in for that sort of banal positivity, so it's got to go. From the left, we can see the original, the Generative Fill, and the Content Aware Fill, which has got things badly wrong by including parts of the chair in its fill and creating a repeating pattern. We could have made this better by directing the tool to sample more appropriate areas of the image, but with Generative Fill, there's no need—it has produced a perfectly smooth result.





» Doing this isn't immediately obvious, as Adobe hasn't included a Generative Fill button on the floating toolbar. Instead, once you've made your selection, either head to the Edit menu and choose Generative Fill from below Content Aware Fill, or hit Generate on the toolbar without including a prompt. That you can do this is one of Photoshop's misunderstood features—simply set the AI going, and it will probably work out what you want. It doesn't always work—we tried it on the windows in the back of the picture to see if it would remove the trees and leave the sky, but instead it replaced the window with a similar one that had opaque panels, rather spoiling the view. However, if you've got a photo that has power lines in it, and want to stop them spoiling a pristine winter sky, making a selection and hitting the Generate button can be the easiest way to remove them, though you'll probably have to do some tidying up around the edges by hand.

4

SELECT SUBJECT

Open a file, and the first thing the floating toolbar offers you is Select Subject, which as you'd expect, places the familiar Photoshop marching ants border around what it considers to be the subject of the photo. This tool is one of the new features that offers you a choice. Do you want to process the selection on your PC, or do you want to send it to the cloud so Adobe's servers can work on it? Open Edit > Preferences > Image Processing, and you can pick whether to keep it on your device, which offers quicker results, as well as the knowledge that your data isn't leaving your PC, or you can opt to use the cloud for more detailed selections. If you change this setting, you'll need to restart Photoshop for it to take effect. Hair has always been a problem for automatic selection tools, so we picked a portrait of a lady with curly hair to see how the two methods coped. [**Image C**] shows a side-by-side comparison of the results, with the background removed to show the effect of the selection. On the left is the original, in the center the on-device processing, and on the right is the cloud-processed version. The cloud has done a better job, but the difference is subtle, with the on-device processing producing a more angular result that hasn't respected the edges of the lighter areas as well. Still, both have done a better job than the Magic Wand tool would have done, and the cloud processing of a 2.5MB JPEG file took about the same amount of time as on-device work. If you're dealing with files that are hundreds of megabytes in size, then your experience may differ, especially if you are at the mercy of a slow internet connection.

» Out of interest, we tried pressing the toolbar's Generate button with no prompt while the portrait subject was selected, and to our utter astonishment it replaced the woman with what appears to be a dandelion seed head on a long stem with leaves on it [**Image D**]. Sometimes, the modern world can be a baffling place.

5

LAYERS

One of the best things about the way Adobe has integrated AI is how it works with the Layers palette. In [**Image E**], the portrait has had a bit of Generative Expand applied to the bottom right-hand corner, and the new data has been added as a layer on top of the original Background layer, so you can use the familiar eye icon to toggle it on and off. It also adds a Layer Mask, so you can quickly select the generated area and apply effects to it, which is useful if you've added an object into a scene and want to fade it out.

6

PROPERTIES

The Properties palette, which by default appears on the right-hand side of the Photoshop interface, houses some of the generative AI tools, and is especially

POISONING THE WELL

AI image generation models require a constant stream of real, human-created images to train on in order to keep up with photographic trends and to create new, better, image generation models. A phenomenon known as 'model collapse' occurs when an AI model is trained using 'synthetic' data, which in this case means images created by other AI image generation systems, and leads to gradual degeneration of the output produced. Having AI models feeding on each other, at least at the current level of sophistication, gets you unsatisfactory results that only get worse over time. This means generated images may always have to live alongside real human photography and art.

There's also Nightshade, a technology from a team led by a professor at the University of Chicago, that allows photographers to add invisible data to the digital images they put online that humans can't see, but which will mess with AI models if these images are ever scraped up and fed into the unquenchable black hole of the artificial mind. The manipulated data exploits the neural network to fool it into thinking it's seeing something that is not there, and in the words of the MIT Technology Review: "Dogs become cats, cars become cows".

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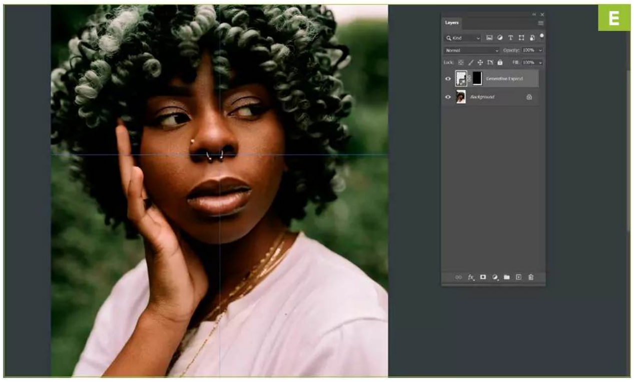
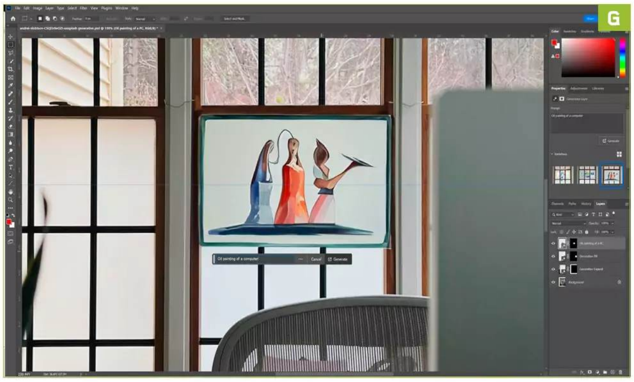




Oil painting of a computer

useful after you've created something and have the Generative layer selected. To begin with, however, it houses a slightly larger prompt box than the one in the floating toolbar, and it can be used if the bar is hidden or has mysteriously vanished. In this box, you can type either your wildest dreams, or something more prosaic and related to your current project [**Image F**]. There's a Generate button to put your request into action, and a button at the top that changes the panel back to the old, familiar Layer Mask options panel. Note that if you switch between these two modes with a prompt written in the box, but not yet generated, your words will be gone when you swap back.

7 VARIATIONS

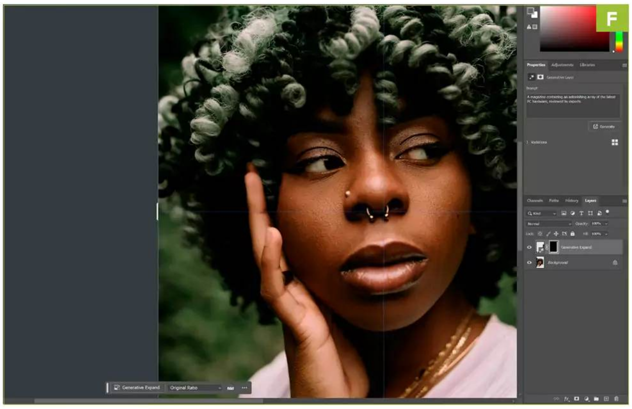
That motivational sign at the back of the desk and chair photo has got to go, and what better to replace it with than a lovely oil painting of a PC? More people should use the architectural style and RGB colors of a gaming rig as their wall art, in our opinion, so let's use the prompt, 'Oil painting of a computer' in a selection covering the sign. What we get [**Image G**] isn't quite right, though it's better than the result of the prompt 'Oil painting of a PC', which produced a Rothko-like smear. Exactly what's gone wrong here, we're not sure, though it might be that the prompt wasn't specific enough. Changing it to 'Oil painting of a gaming PC in the style of an old master' produces something recognizably PC-like, with a mouse, keyboard, and some wires, but no monitor.

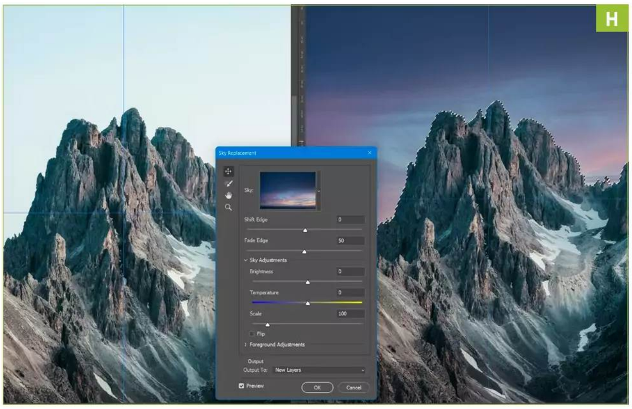
» Each time you generate an object or use Generative Fill, three variations are produced that you can flip through using the Properties palette. The other two variations produced for our PC oil painting prompt are abstract daubs clearly based on the panels in the window behind the sign rather than what we actually asked for. As an experiment, we created a new document and input the same prompt against a plain white background, which produced something much more suitable, and which could be composited into a frame to cover up the motivational sign. The way in which Photoshop's AI tools take the context of the surrounding image into account, rather than just slapping something inside your selection boundary, is one of its most powerful features that sets it apart from image generators such as Midjourney.

8 LITTLE FLUFFY CLOUDS

Two new tools can be combined for a fast and powerful effect. On the Select menu, you'll find a Sky option, which on a suitable photograph will select the sky. Then, on the Edit menu, an option for Sky Replacement nestles below Auto-Blend Layers. Click it, and you'll be given options to replace the sky with a selection from a folder of actual photos of the sky that's provided. There's a '+' button so you can add your own, too. The Sky Replacement window [**Image H**] allows you to alter the lighting and position of the new sky to more realistically blend it in with the foreground image. All of these Sky Replacement effects are applied as layers, including lighting groups, with Levels adjustment layers and layer masks, so it's possible to tweak whatever the system creates to your liking.

» We tried a Generative Fill on the same selection, and not only did it produce a much more dramatic and colorful result than the supplied photos, but added extra mountains to the image, too, which we hadn't asked for. This typifies Adobe's approach to the integration of AI with its creative tools, treating it as an option that may surprise you, but which is still under the control of the artist, rather than as a replacement for the human mind guiding the process. Crucially, it can be switched off and ignored at those times when the old way of doing things remains the best. ⏻





Shift Edge 0
Fade Edge 50
Sky Adjustments
Brightness 0
Temperature 0
Scale 100
☐ Flip
Foreground Adjustments
Output
Output To: New Layers
☑ Preview

Use parental controls in Windows 11

YOU'LL NEED THIS

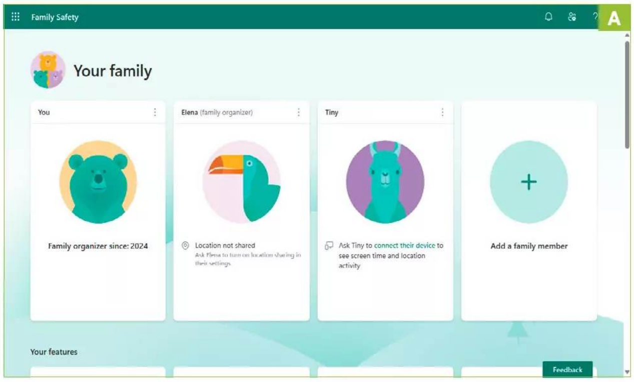
AN ACTIVE MICROSOFT ACCOUNT for each family organizer/member

WHILE THE INTERNET can be a great tool to help kids learn and socialize with their friends, children sometimes struggle to put down their devices. The more time they spend online, the greater the risk that they'll be exposed to unsuitable content.

There's no substitute for being there each time young people in your care go online. Still, given the rise of portable devices and how ubiquitous the internet is, parents and guardians can't always be there. Fortunately, Windows 11 offers some powerful parental controls, which you can use to manage your child's computer usage free of charge. In this guide, you'll find out how to set up Microsoft Family Safety and create accounts for you and your kids.

You'll learn how to set limits to how long they can spend online, or limit logins. You'll also discover how to configure Edge to screen inappropriate content, as well as set up 'block' and 'allow' lists. You can even view which apps and games have been used and block them.

We'll also explore some common workarounds to bypass parental controls and provide details on how to outfox your little angels if they try to do the same. –NATE DRAKE


A
Family Safety
Your family
You
Family organizer since: 2024
Elena (family organizer)
Location not shared
Ask Elena to turn on location sharing in their settings
Tiny
Ask Tiny to connect their device to see screen time and location activity
Add a family member
Your features
Feedback

1 FAMILY FIRST

In the Windows search bar, enter 'Family' to launch 'Family options'. Select 'View family settings to begin.' This will launch Microsoft's 'Family Safety' portal. [Image A]

» To get started, choose 'Add a family member'. At this stage, you'll be asked to add your child's phone number or email. If your child doesn't already have a Microsoft account, select 'Create an account'.

» Microsoft will now prompt you to enter an email address for your child. Choose 'Get a new email address'. From here, you can create a new '@outlook.com' or '@hotmail.com' address.

» You'll next be prompted to enter a password to use with the account. Ask your child to enter one, then click 'Next'. They will then be asked to enter the first and last name, then choose 'Next' again.

» At this stage, you can reassume control of your device and enter your kid's current region, as well as their date of birth. You may need to complete a CAPTCHA challenge in order to finalize account creation.

» When you return to the Family Safety portal, you'll see the newly created account. You should also see that your own account has been designated 'Family Organizer'. Effectively, this makes you an administrator, allowing you to manage your child's limits and permissions when using Windows.

» At this stage you can repeat the steps above to add other children to your family group. If you wish to add another organizer, eg. your spouse, simply click 'Add Family Member', then enter their email address. Microsoft will prompt you to choose their role. Select 'Organizer', then 'Invite'. They can either click the link to accept or you can choose 'Accept Now', so log you out and have them sign in via their own Microsoft account.

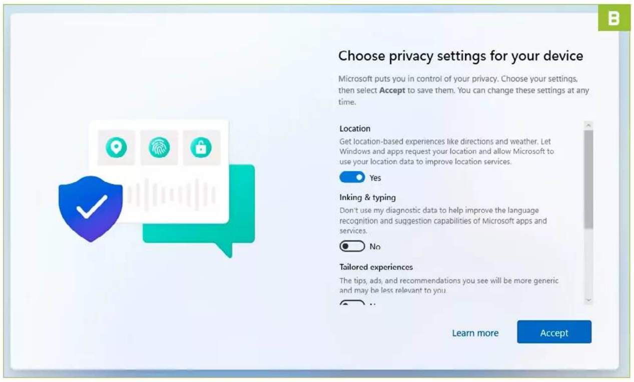
2 SIGN YOUR CHILD IN

If you've just created a new account for your child, then you'll need them to sign in to a device.

» In order to do this from Windows 11, type 'Users' into the search bar to open 'Other Users' in System Settings.

» Once here, click 'Add Account' at the top right. You'll be asked once again to enter the email address associated with your child's account. Click 'Next' to confirm. By default, your child should be added with a 'Standard' rather than an 'Administrator' account. Standard accounts can't make system-wide changes like installing programs, so double-check this is the case by selecting 'Change account type'. [Image B]

» Once the account is set up, open the Start menu and click on your username. The email address associated with your child's account should now appear. Select this, and ask your kid to click 'Sign In'. They can then enter the password associated with their Microsoft account. Windows Security will also prompt them to



Choose privacy settings for your device

Microsoft puts you in control of your privacy. Choose your settings, then select **Accept** to save them. You can change these settings at any time.

Location

Get location-based experiences like directions and weather. Let Windows and apps request your location and allow Microsoft to use your location data to improve location services.

● Yes

Inking & typing

Don't use my diagnostic data to help improve the language recognition and suggestion capabilities of Microsoft apps and services.

○ No

Tailored experiences

The tips, ads, and recommendations you see will be more generic and may be less relevant to you.

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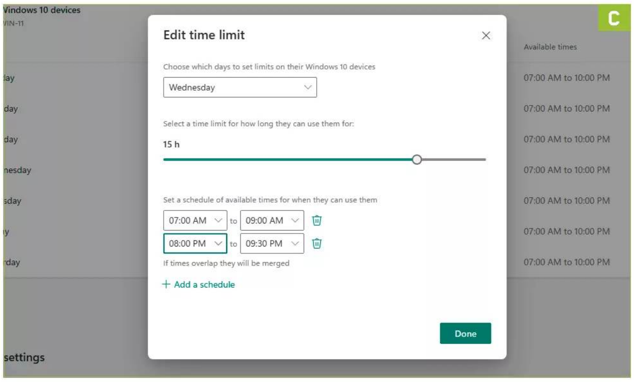

C

Windows 10 devices

WIN-11

Edit time limit

Choose which days to set limits on their Windows 10 devices

Wednesday

Select a time limit for how long they can use them for:

15 h

Set a schedule of available times for when they can use them

07:00 AM to 09:00 AM

08:00 PM to 09:30 PM

If times overlap they will be merged

create a Windows Hello PIN at this stage for simple sign in. This feature is optional, so either enter a PIN and choose 'OK', or just press 'Cancel'.

» If this is your child's first time signing in via this account then Windows 11 will take a few moments to load the desktop. If prompted to back up files with OneDrive, choose 'Only save files to this PC' for now.

» Windows will now prompt you to choose 'Privacy Settings'. You may wish to leave 'Location' enabled to keep track of your device or your child's, but we recommend disabling the others. Click 'Accept' to finalize sign in.

3 SET SCREEN TIME LIMITS

Screen Time allows you to decide when and for how long your child can sign in to devices.

» Before getting started, first double-check that your child has been added correctly. Type 'family' into the Windows search bar to open 'Manage Family Group'. If your child isn't listed under 'Your family', you can click 'Add someone' to try again.

» Next, choose 'Open Family Settings' to return to the Family Safety portal. Select your child's name, then choose 'Turn on Activity Reporting'. [Image C]

» Be sure to read the notice about insights, specifically that kids over the age of 13 can choose to switch it off. You can now scroll down to the bottom of the page and select 'Turn limits on'.

» Once enabled, Screen Time defaults limit your kids to a total of 15 hours of activity from 7am to 10pm each day. Click on any day to amend. From here, you can choose any day using the drop-down menu. You can also use the slider bar to change your kid's total login time. Note that any time signed in counts towards this limit, so your child will need to sign out of their account on all devices to pause the timer.

» You can also schedule certain times of day during which logins are allowed. Click 'Add a Schedule' to add another time period. When you're finished, click 'Done' to save any changes.

» If your child tries to log in outside the assigned times/limits, they'll see the 'Time for a break' notification. From here, they can choose 'Request More Time'. You'll receive a notification via Microsoft Family Safety to approve their request.

4 SET UP CONTENT FILTERING

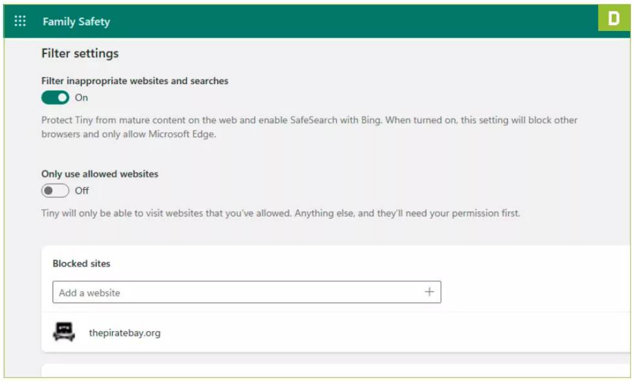
Content filtering can be used to block most harmful content from loading in Microsoft Edge. You can also set up a white list of family friendly websites, blocking all others.

» To activate this feature, click on your child's name via the Family Safety portal. Next, choose 'Edge', from the list of various devices at the top left. [Image D]

» Under 'Filter Settings', change 'Filter inappropriate websites and searches' to 'on'. In theory, this enforces Bing SafeSearch and will block mature content in Edge, as well as blocking other browsers.

» By default, Activity Reporting is turned on for Edge, so you can see what sites they've visited in the browser.

» The 'inappropriate websites' filter isn't perfect—for instance, during our tests it quite happily loaded The Pirate Bay's main website, so you can also ban specific domains by entering them in the 'Blocked Sites' field.


D

Family Safety

Filter settings

Filter inappropriate websites and searches

● On

Protect Tiny from mature content on the web and enable SafeSearch with Bing. When turned on, this setting will block other browsers and only allow Microsoft Edge.

Only use allowed websites

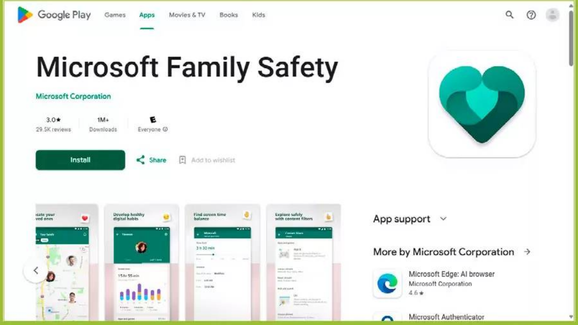
○ Off

Tiny will only be able to visit websites that you've allowed. Anything else, and they'll need your permission first.

Blocked sites

thepiratebay.org

CONNECTING OTHER DEVICES



Microsoft Family Safety

Microsoft Corporation

3.0★ 29.5K reviews | 1M+ Downloads | E Everyone

More by Microsoft Corporation

Microsoft Edge: AI browser
Microsoft Corporation
4.6★

Microsoft Authenticator

Family Controls should work out of the box on all Windows 11 devices. If you want to monitor and set limits on other devices, though, there's some extra work involved.

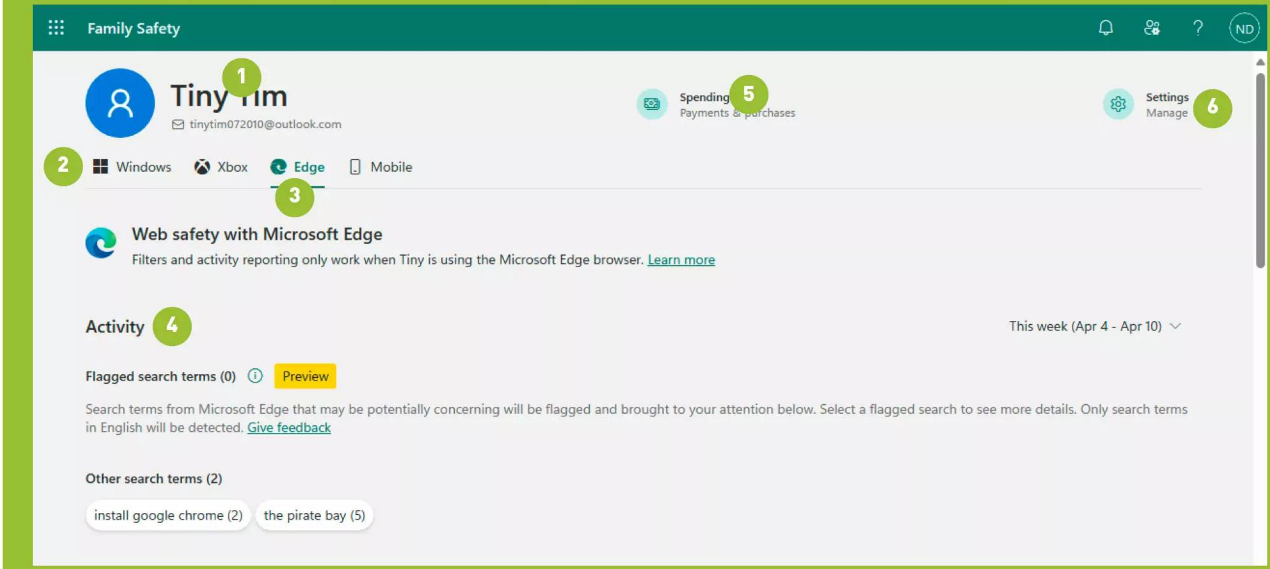
If your child's using a Windows 10 device, sign in with your Microsoft account. Search to find 'Settings', then go to 'Accounts' > 'Family & other people'. Find the 'Your Family' section and select your child's name. Choose 'Allow'. When they sign in via their Microsoft account, monitor them from the Family Safety portal.

If your child has an Xbox One or any subsequent model, press the main button on the controller to open up the guide. Choose 'Sign in' > 'Add New', and ask your child to sign in with their Microsoft account.

While Android tablets aren't supported, you can install the dedicated Microsoft Family Safety app on Android phones via Google Play. Follow the instructions onscreen to make sure the app has the necessary permissions.

As with Android tablets, the iOS version of the Microsoft Family Safety App isn't yet available for iPad, but can be installed on iPhones via the Apple Store.

CONFIGURE FAMILY SAFETY PROFILE



Web safety with Microsoft Edge

Filters and activity reporting only work when Tiny is using the Microsoft Edge browser. Learn more

Activity

This week (Apr 4 - Apr 10)

Flagged search terms (0)

Search terms from Microsoft Edge that may be potentially concerning will be flagged and brought to your attention below. Select a flagged search to see more details. Only search terms in English will be detected. Give feedback

Other search terms (2)

install google chrome (2)

the pirate bay (5)

1. MICROSOFT ACCOUNT
Kids must have a valid email address or Microsoft account to be added to your 'Family Group'. If your child doesn't have these, you can create an account during the setup process.

2. WINDOWS
Click on this section to view your child's recent usage. From here, you can also list and block recent apps or games, as well as set screen time limits and schedules.

3. EDGE
This section allows you to view any flagged search terms, as well as set up block or allow lists for certain sites. You can also filter most inappropriate sites and searches in Edge.

4. ACTIVITY
Enable 'Activity Monitoring' for each section, like 'Windows' or 'Edge', to view a summary of your child's actions. Once they reach age 13, they can disable monitoring from their account.

5. SPENDING
You can manage your child's spending by topping up their account via a preset amount, eg. $10. You can also add your credit card, then have them request approval for each purchase.

6. SETTINGS
From here, you can set an age rating to make sure your child doesn't access unsuitable apps or media. You can also request an email summary of your child's activity.

» This can get tedious, so for younger children, you may prefer simply to specify which websites they're allowed to access instead. To do this, simply enable the switch marked 'Only use allowed websites'. Use the corresponding 'Allowed sites' field to determine which these will be.

» If your child tries to visit a restricted site, they'll also be prompted to 'Ask Now' to request access to it, which you can then approve or deny via the Family Safety Center as you see fit.

5 LOCK DOWN YOUR BROWSERS

Sharp-eyed readers will have noticed that the content-filtering features set up in the previous step can be accessed by the 'Edge' section.

» This is because such filters only apply to Edge itself, not third-party browsers. In theory, if your child has a 'Standard' user account on their device, they shouldn't be able to install extra software. But some browsers like Chrome can be installed without administrator privileges. You also may have other browsers already installed on your system.

» If this is the case, you need to test that your child can't use these other browsers. First have them sign in to their device, then try to launch the third-party browser. If Family Controls are set up correctly, shortly after launching they'll see a notification saying 'You'll need to ask to use this app'. From here, they can click 'Ask to use' if they have a legitimate reason for doing so.

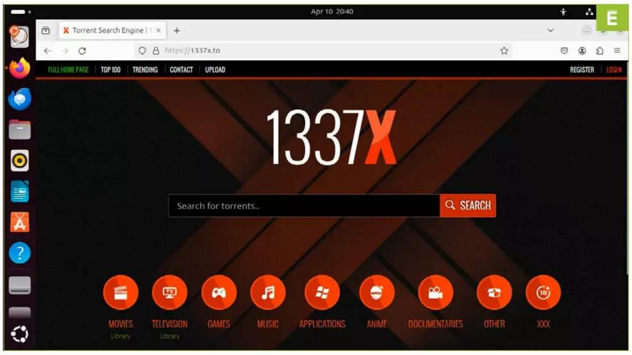
» Despite Microsoft's claims that other browsers won't run when 'Filter inappropriate websites and searches' is enabled, during our tests we found that this wasn't the case. Using the child account, we downloaded and ran a compressed version of the 'Pale Moon' browser, which happily loaded a website that was blocked by Family Controls (The Pirate Bay). The same thing happened using the LibreWolf browser.

» The good news is that if your kid tries to work around Family Controls in this way, they'll need to use Edge to download the third-party browser, so you'll see a record of their visit. Sensitive search terms like 'install Google Chrome' will also be flagged. If Activity Monitoring is enabled, you can also see a list of recently run programs by going to Windows > Apps & Games in the Family Safety portal. From here, you can also click to enable 'App & Game Limits'. Click the options (...) button next to any browser and choose 'Block App'.

» If you're running Windows 11 Pro, Education, or Enterprise, you can also set local policies to block execution of specific apps.

» First, launch the Group Policy Editor. Type 'gpedit.msc' into the Windows search bar, then press Enter. Double-click on 'User Configuration' > 'Administrative Templates' > 'System' in the main pane.

© MICROSOFT



» From here, find the policy named 'Don't run specified Windows application' and double-click to open. Click 'enabled' at the top left, then add a helpful 'Comment' if you wish. Next, choose 'Show' next to 'List of Disallowed Applications'. You can now individually list blocked programs, eg. 'palemoon.exe'.

» Click 'OK' when you're done, then 'Apply' to save changes. The new policy will apply next time you restart your device.

» Remember, enabling this feature will block these applications for everyone, not just your child. As it blocks specific file names launched via Windows File Explorer, kids can still get around it by renaming the executable or by launching blocked programs via Windows Terminal. For this reason, make sure you inspect your child's devices regularly for third-party browsers.

6 GIVE USBS THE BOOT

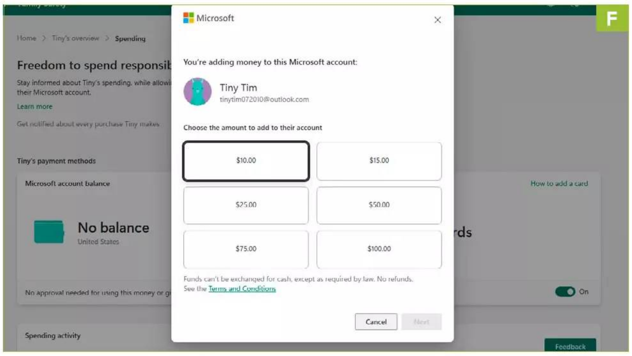
Even if you lock down all third-party browsers, your child may still be able to get online at any time of day by booting another operating system on your computer, like Linux. Popular operating systems like Ubuntu can easily be installed to a USB stick, then booted from a Windows device. If your child does this, they won't be restricted by any Windows screen time limits [**Image E**]. They also can't be blocked or recorded by Activity Monitor.

» Windows 11 does have a 'Secure Boot' feature to prevent loading of harmful software but it's not designed to block legitimate operating systems like Ubuntu Linux.

» For this reason, you need to modify your UEFI settings to prevent booting by USB devices. The specific steps you need to take to do this will vary depending on your device manufacturer. Generally, you can access these by holding down a function key when your device is booting, eg. F2.

» Some manufacturers like HP actually have a specific section for 'USB Boot Support', which you can disable. In most cases, though, you'll need to modify the device's 'Boot Order', placing the hard disk first.

» Make sure you also set a firmware password so that your child can't reboot and change these settings.



You're adding money to this Microsoft account:

Tiny Tim
tinytim072010@outlook.com

Choose the amount to add to their account

Funds can't be exchanged for cash, except as required by law. No refunds. See the Terms and Conditions

Freedom to spend responsib

Stay informed about Tiny's spending, while allowi their Microsoft account.

Learn more

Get notified about every purchase Tiny makes

Tiny's payment methods

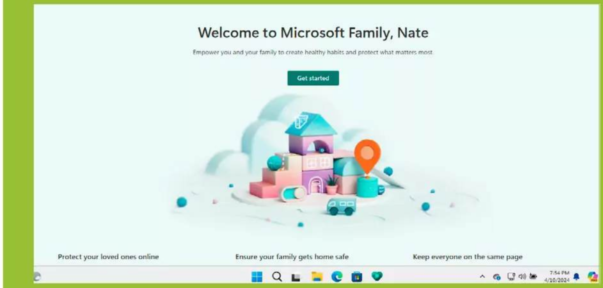
Microsoft account balance

No balance
United States

No approval needed for using this money or g

Spending activity

INSTALL MICROSOFT FAMILY SAFETY APP



Welcome to Microsoft Family, Nate

Empower you and your family to create healthy habits and protect what matters most

Protect your loved ones online

Ensure your family gets home safe

Keep everyone on the same page

Although you can manage parental controls settings by pointing your browser to https://family.microsoft.com, there is a dedicated 'Family Safety' app available from the Microsoft Store.

The app has a similar look and feel to the website, and the functions are the same, but if you prefer a dedicated program, type 'Family Safety' into the search bar to pull up the app landing page. The first thing you'll notice is that the app has low review scores, but as one parent has pointed out, these are mostly from kids and teens frustrated that they can't use third-party browsers like Chrome or games such as Roblox. In other words, the parental controls work.

Click 'Install', then 'Launch' to open Family Safety (Windows will refer to the program as 'Family' from now on). On first launch, select 'Get Started', to load your Family Safety settings. As we mentioned, the interface is virtually identical to the website. The only exception is the 'Your Features' section, as if you click any of the links for tasks like 'How do I set up content filters', the relevant page will open on Microsoft's support site rather than in the app.

There's also a dedicated app-specific button at the top right to 'Leave Feedback', though we suggest only parents use this to provide constructive criticism!

7 SET SPENDING LIMITS

Once you're sure your child is staying within Microsoft's ecosystem, you can help them to buy movies, games, and in-app purchases via their account.

» To manage spending, open the Family Safety Center, and tap/click on your child's name. Next, choose 'Spending' at the top right. Here, you can select 'Turn on Activity Reporting' to keep track of your kid's purchases.

» There are two ways to manage your child's spending. The first is by adding a set balance to their account. Access this via 'Add Money' at the top left, at which point you'll be asked to choose a fixed sum, depending on your country. Click 'Next' to make a one-time top-up by credit card or eWallet, eg. PayPal. [**Image F**]

» Alternatively, add your credit card to their account. By default, the option to require your approval for each purchase is enabled. To do this, ask your child to sign in to their Microsoft Account via https://account.microsoft.com. Have them click their profile icon at the top right and choose 'My Microsoft Account'. Click on 'Payment Options' in the left-hand pane, then 'Add a New Payment Method'. Once your details are saved, the card will appear in the Family Safety Center.

Prevent browser fingerprinting

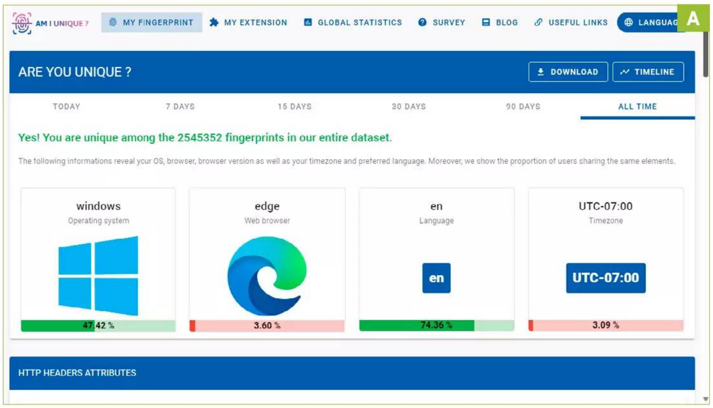
YOU'LL NEED THIS

Admin privileges
Stable internet connection

HAVE YOU NOTICED that no matter how many times you up your browser's security level, decline cookies, and click 'Do Not Track', it feels like websites still know your browsing habits?

Browser fingerprinting is a way of identifying you through the information your browser sends when it visits a web page. Some of this information is contained in the 'User-Agent' header, which gives the site basic information about your browser version, operating system, language, time zone, and so on. This can be combined with other data to form a unique 'fingerprint'.

This is a very serious risk for your privacy, as unlike your browsing history, fingerprints are stored on remote servers, so can't be deleted. In this guide, you'll learn how to check your fingerprint, as well learn methods to throw unscrupulous websites off your track. –**NATE DRAKE**



Yes! You are unique among the 2545352 fingerprints in our entire dataset.

The following informations reveal your OS, browser, browser version as well as your timezone and preferred language. Moreover, we show the proportion of users sharing the same elements.

1 CHECK YOUR FINGERPRINT

There are a number of tools you can use to check whether your browser fingerprint is unique or not. These include the EFF's 'Cover Your Tracks' (https://coveryourtracks.eff.org), as well as 'Am I Unique?' (https://amiunique.org) [**Image A**].

» These tools don't just show how easy it is to profile your browser activity; they also list the many fingerprinting methods used by websites. For instance, during our tests using Microsoft Edge in a Windows 11 virtual machine, we found that the 'User Agent' header, which provides websites with information about your browser and OS, was shared by just 0.05 percent of other web users.

2 USE A SECURE BROWSER

Developers of mainstream web browsers do their best to reduce fingerprinting where possible—for instance, by providing more generic language information, like 'English' instead of 'Australian English'.

» Still, this can cause issues when loading certain web pages, plus there are many different ways to identify your browser.

» The most secure browsers, like Brave (https://brave.com), use a randomized fingerprint instead. This technique, known as 'farbling', involves generating new values each user session, making your browser much harder to track.

» If you do choose to install a secure browser that does this, like Brave, then use an online tool like 'Am I Unique' to check your fingerprint—the site may still tell you that your browser is unique. [**Image B**] Still, the browser will generate a new fingerprint next time you close and reopen it, protecting your privacy.

3 BLOCK TRACKING COOKIES

Although cookies aren't a form of fingerprinting, strictly speaking, they can be analyzed for the UID (Unique Identification) of your browser when you're online. For instance, Facebook 'widgets' can be found in thousands of third-party websites and can send the web address back to Meta, along with a crafted cookie, giving Facebook insight into your browsing habits.

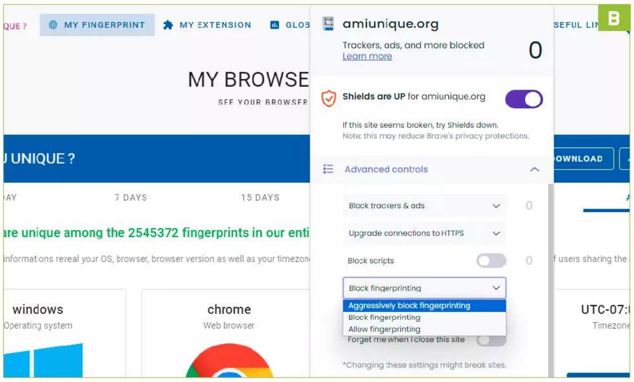
» Technically, you can circumvent this by placing your browser in 'Private' or 'Incognito' mode, as cookies are erased after each session. Still, if you sign into your account first, then visit a page with a widget, Facebook would still be able to record your browsing habits.

» The web extension, Ghostery (https://ghostery.com) [**Image C**] is designed to block both annoying ads and tracking cookies. Although browsers can be fingerprinted based on installed plugins, it also has built-in code to block identifying information being gathered. The extension is available for all major browsers.

4 VPN BEST PRACTICES

Network identification (via your IP address) is an easy way for websites to identify users. As your 'public IP' is assigned by your ISP, it's easy for websites to profile you and work out your approximate location.

» If you use a reputable VPN service, your device connects to the web securely via a dedicated VPN server. As your public IP matches that of the server, it's much harder for sites to perform network identification, given that other VPN users share the same IP.



are unique among the 2545372 fingerprints in our enti

informations reveal your OS, browser, browser version as well as your timezon

f users sharing the

Trackers, ads, and more blocked 0

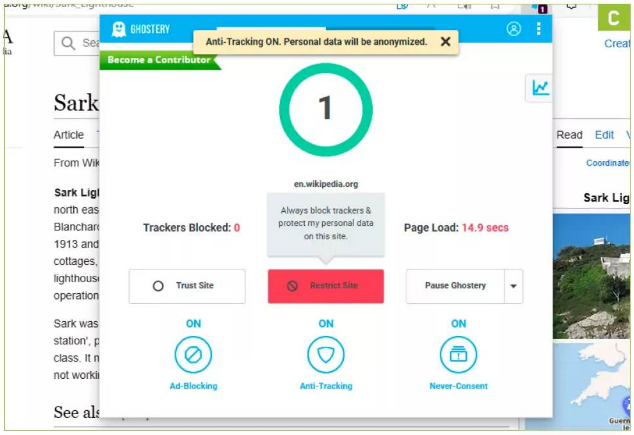
Shields are UP for amiunique.org

If this site seems broken, try Shields down.
Note: this may reduce Brave's privacy protections.

Block trackers & ads 0
Upgrade connections to HTTPS
Block scripts 0
Block fingerprinting
Aggressively block fingerprinting
Block fingerprinting
Allow fingerprinting
Forget me when I close this site

*Changing these settings might break sites.

© HTTPS://AMIUNIQUE.ORG, HTTPS://GHOSTERY.COM


C
GHOSTERY
Anti-Tracking ON. Personal data will be anonymized.
Become a Contributor
1
en.wikipedia.org
Always block trackers & protect my personal data on this site.
Trackers Blocked: 0
Page Load: 14.9 secs
Trust Site
Restrict Site
Pause Ghostery
ON
Ad-Blocking
ON
Anti-Tracking
ON
Never-Consent

» Some VPN services offer a static IP. These have their advantages, such as stopping you from being banned from gaming websites due to other VPN users' bad behavior. Still, a fixed IP makes you easier to identify. You could also try to connect via a different VPN server each time you go online.

» When connecting to your VPN, make sure to do so via the VPN client software rather than via a browser extension, as plugins can be used to fingerprint you. [**Image D**]

5 BLOCK CANVAS FINGERPRINTING

The Canvas API is designed to draw graphics. If a web user visits a page containing an HTML5 canvas element, the browser will render it in slightly different ways, depending on your hardware and software configuration. These subtle variations can be used to fingerprint your activity.

» If you're using a secure browser like Brave then your canvas fingerprint is already randomized, so while it may appear unique, it will be different each time you reopen your browser.

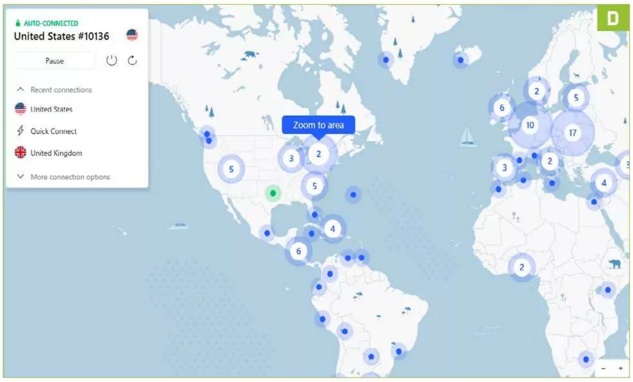
» To achieve the same thing in regular web browsers, consider installing a dedicated extension like CanvasBlocker, which can also add random 'noise' to your Canvas fingerprint each time you're online. [**Image E**]

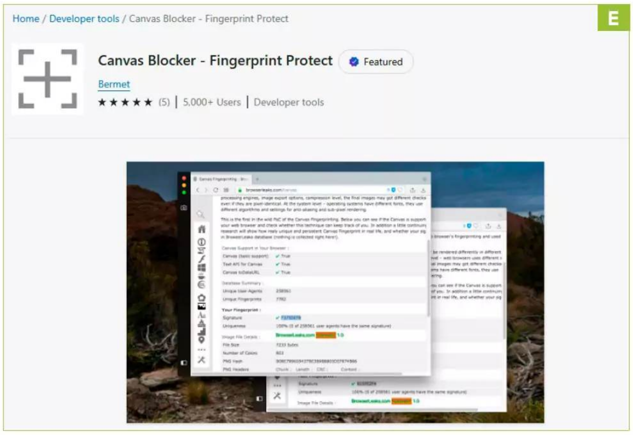
6 BLOCK WEBGL FINGERPRINTING

WebGL (Web Graphics Library) fingerprinting operates in a similar way to Canvas fingerprinting by drawing an invisible 3D graphic inside your browser.

» As each device renders the image slightly differently, this can easily be used to identify you.

» You can prevent most types of WebGL fingerprinting through use of yet another extensions such as 'WebGL Fingerprint Defender' but remember the type and combination of browser plugins on your device is another way it can be fingerprinted.


D
AUTO-CONNECTED
United States #10136
Pause
Recent connections
United States
Quick Connect
United Kingdom
More connection options
Zoom to area

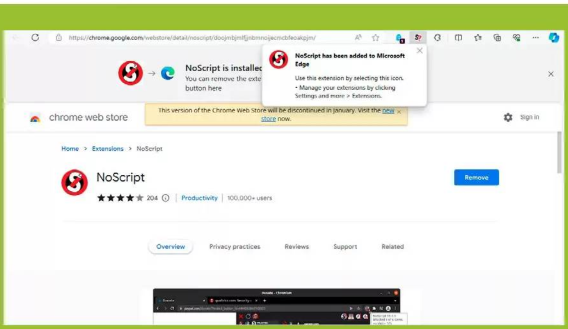

E
Home / Developer tools / Canvas Blocker - Fingerprint Protect
Canvas Blocker - Fingerprint Protect
Featured
Bermet
★★★★★ (5) | 5,000+ Users | Developer tools

» Alternatively, you can just disable WebGL. In Chrome, simply type 'chrome://settings/system' in the address bar and press enter. You can now disable the 'Use graphics acceleration when available' option.

» You can also view and disable this same option In other Chromium-based browsers like Edge and Brave simply by changing the browser name in the address bar, then pressing enter, eg. 'edge://settings/system'.

» If you use Firefox, type 'about:config' in the address bar and hit enter. In the search box type 'webgl.disabled'. You can now change this value from 'false' to 'true'.

» Users of the Firefox-based Tor Browser have an advantage, as the program is designed to resist fingerprinting, including a minimalist version of WebGL. It also incorporates the NoScript plugin (see Box Out), which prevents almost all forms of fingerprinting.


NoScript is installed
You can remove the exte… button here
NoScript has been added to Microsoft Edge
Use this extension by selecting this icon.
• Manage your extensions by clicking Settings and more > Extensions.
chrome web store
This version of the Chrome Web Store will be discontinued in January. Visit the new store now.
Home > Extensions > NoScript
NoScript
Remove
★★★★ 204 | Productivity | 100,000+ users
Overview
Privacy practices
Reviews
Support
Related

NOSCRIPT, NO CRY

Secure browsers and specialist plugins can help prevent some common types of fingerprinting, but your browser sends out huge amounts of identifiable information.

The good news is that most fingerprinting techniques rely to some extent on JavaScript. This is where the 'NoScript' extension (https://noscript.net) comes in.

This browser plugin works by proactively block JavaScript on pages until you manually enable it. This means you can only allow those scripts to run which you actually need to use with the site.

If you're using a trusted domain, eg. a self-hosted blog, you can also have NoScript temporarily or permanently whitelist the entire site. Similarly, you can block JavaScript across an entire domain, though in this case the page almost certainly won't load correctly.

©HTTPS://NOSCRIPT.NET

Convert Media Files with VLC

YOU'LL NEED THIS

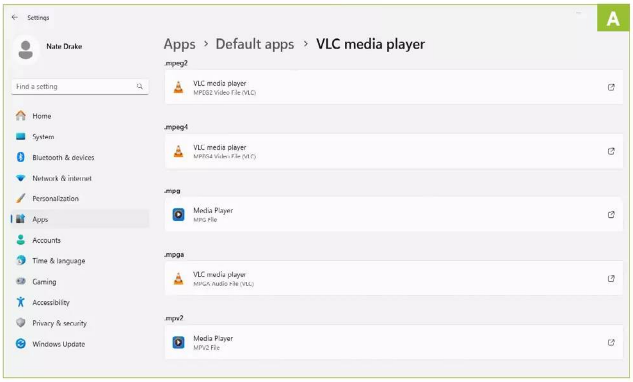
An up-to-date version of VLC Media Player

SINCE 2001, VLC Media Player (Previously 'VideoLAN Client') has developed a solid reputation as a lightweight and free media player. It supports a huge number of media types, DVD playback, and even streaming video.

VLC uses the open-source libavcodec library, meaning it supports virtually all codecs and file formats well beyond what Windows and most other operating systems can play natively.

The program is well known for its icon, which takes the form of an orange traffic cone. What's less well known is that VLC is much more than just a simple media player—the program can actually convert files from one media format to another.

In this guide, you'll learn how to get set up with VLC and point it to your source file for conversion. You'll also discover how to select a new media container format, as well as specify both audio and video codecs for your new file. **–NATE DRAKE**



Apps › Default apps › VLC media player

.mpeg2
VLC media player
MPEG2 Video File (VLC)

.mpeg4
VLC media player
MPEG4 Video File (VLC)

.mpg
Media Player
MPG File

.mpga
VLC media player
MPGA Audio File (VLC)

.mpv2
Media Player
MPV2 File

1 SET UP VLC

If you don't already have VLC installed, you can download it from www.videolan.org or via the Microsoft Store.

» On first launch, make sure you read the details of VLC's privacy and network access policy. This is simply a guarantee that your personal information won't be transmitted, but the player can download metadata like album cover art for media files you play. If you prefer to opt out, simply uncheck the box marked 'Allow metadata network access', then choose 'Continue'.

» By default, Windows 11 will assign VLC as the app to open media file formats that aren't supported by the OS's own media player. [**Image A**]

2 CHOOSE YOUR SOURCE FILE

If you want to convert video because it won't play locally on your PC, you might be able to save yourself the trouble just by opening it in VLC instead. Right-click the file and choose 'Open with' to choose VLC. You can then choose whether to open VLC 'Always' or 'Just Once'.

» If you need to convert the file for any other reason, launch VLC, then click the 'Media' menu option in the top left. Next, choose 'Convert/Save'. In the new 'Open Media' window, click 'Add' to select the source file. VLC also supports selecting multiple files for batch conversion. [**Image B**]

» If you have a subtitle file, e.g. in .srt format, check 'Use a subtitle file' and 'Browse' to its location. Depending on your output format, these may be 'burned' in to the video, meaning they can't be changed or disabled.

3 CONFIGURE CONVERSION OPTIONS

Once you've selected your source file, click the 'Convert/Save' button at the bottom of the window to launch the new 'Convert' window.

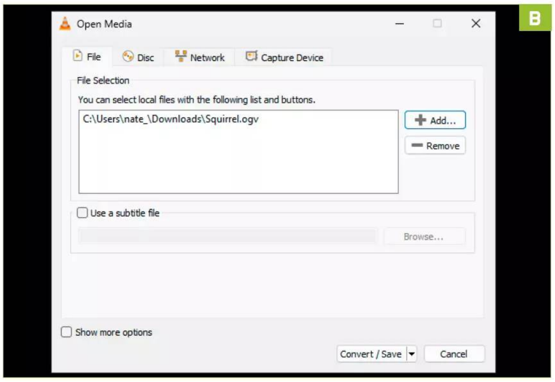
» You can enable the first check box marked 'Display the output' to view the video as it's being converted. As the tool tip warns, this can slow down the process, so we only recommend this if you're trying to troubleshoot conversion issues.

» The 'Deinterlace' option is for converting traditional TV content that updates images via alternating scan lines to displaying full images, as is common for videos playing on computer screens. You can read more about this at https://wiki.videolan.org/Deinterlacing, but bear in mind this necessarily requires some degradation of the output video due to 'temporal interpolation'.

» You can enable the 'Dump Raw Input' option for situations where you want VLC to repackage a media file, but not actually reprocess it into different formats. This is particularly useful when converting DVD audio and video media into a single 'container' file, eg. MP4.

4 CHOOSE YOUR CONTAINER FORMAT

You can use the drop-down menu next to 'Profile' to pick an output format for your media. Naturally, this will vary depending on your needs, but if you want to ensure playback on virtually all media devices, select



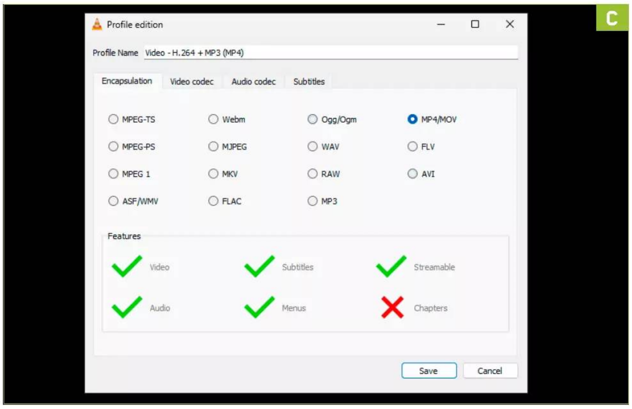
You can select local files with the following list and buttons.

C:\Users\nate_\Downloads\Squirrel.ogv

☐ Use a subtitle file

☐ Show more options

© VLC



Profile Name: Video - H.264 + MP3 (MP4)

○ MPEG-TS ○ Webm ○ Ogg/Ogm ● MP4/MOV
○ MPEG-PS ○ MJPEG ○ WAV ○ FLV
○ MPEG 1 ○ MKV ○ RAW ○ AVI
○ ASF/WMV ○ FLAC ○ MP3

Features
✓ Video ✓ Subtitles ✓ Streamable
✓ Audio ✓ Menus ✗ Chapters

'H.264 + MP3 (MP4)'. This format is also suitable for upload to most video-sharing platforms, like YouTube and TikTok.

» Even if you're happy with the default options, take a moment to click on the wrench icon next to the dropdown menu to 'Edit selected profile'. From here, you can view the 'Encapsulation' tab of the 'Profile Edition' window, which helps you choose the relevant media container format for your video, such as MP4.

» Different containers have different applications. VLC helpfully tells you what 'Features' are supported in the dedicated section in this window. [**Image C**]

» The MP4 container format supports both audio and video, as well as streaming, subtitles, and menus, but not chapters. The ASF/WMV container supports chapters, but not menus.

5 CONFIGURE YOUR CODECS

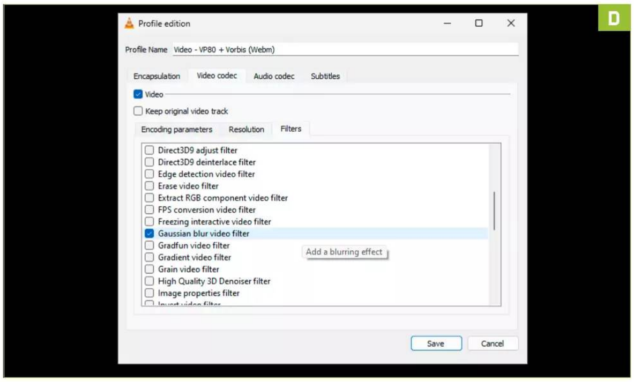
Having chosen your container format in the 'Profile Edition' video, click into the 'Video' tab. VLC will automatically have chosen a video codec to use with the container, but feel free to click on the drop-down menu to explore alternatives. By default, 'Bitrate', 'Quality', and 'Framerate' are blank, but you can enter values manually.

» If you want to make changes in the 'Resolution' tab, VLC only requires you to fill in one of the three parameters. It will then calculate the other two for you.

» For instance, if you select the 'Scale' drop-down menu to make a video twice its original size, VLC can calculate the new resolution accordingly based on the source file.

» Take some time also to explore the 'Filters' tab. These can apply various effects to your video. Hover your mouse over a given filter, such as 'Gaussian blur video filter', to view a tool tip explaining what it does. [**Image D**]

» Next, select the 'Audio Codec' tab from the main 'Profile Edition' window. As with the 'Video' tab, you'll see that a codec has been selected by default in the relevant drop-down menu, eg. 'MPEG Audio'. VLC will also define a 'Bitrate' and the number of audio 'channels' and 'Sample Rate' in the relevant fields, but you can adjust these if you wish.

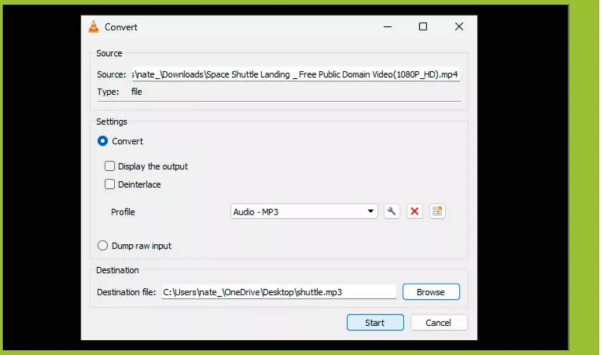


Profile Name: Video - VP80 + Vorbis (Webm)

☑ Video
☐ Keep original video track

☐ Direct3D9 adjust filter
☐ Direct3D9 deinterlace filter
☐ Edge detection video filter
☐ Erase video filter
☐ Extract RGB component video filter
☐ FPS conversion video filter
☐ Freezing interactive video filter
☑ Gaussian blur video filter
☐ Gradfun video filter
☐ Gradient video filter
☐ Grain video filter
☐ High Quality 3D Denoiser filter
☐ Image properties filter

EXTRACTING AUDIO



Source: :\nate_\Downloads\Space Shuttle Landing _ Free Public Domain Video(1080P_HD).mp4
Type: file

● Convert
☐ Display the output
☐ Deinterlace
Profile: Audio - MP3
○ Dump raw input

Destination file: C:\Users\nate_\OneDrive\Desktop\shuttle.mp3

VLC is also a great tool for extracting the sound from video files like music videos and outputting as an audio file.

To get started, simply follow the first three steps outlined above to set up VLC and choose your source file. When it comes to selecting your container format, click into the 'Profile' and choose one of the four audio options: OGG, FLAC, MP3, or CD.

At this stage, you can click the wrench icon, then the 'Audio Codec' tab to adjust the codec, bit rate, channels, and sample rate, just as for a video file.

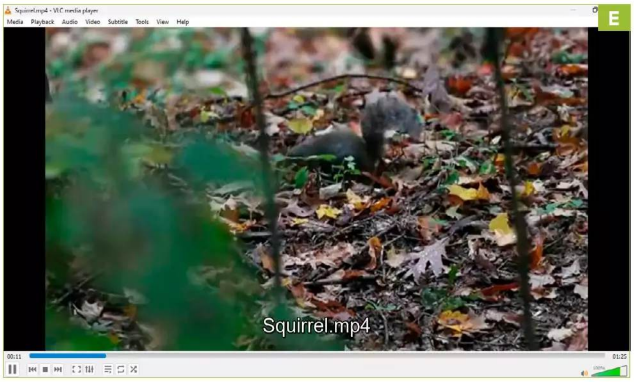
Click 'Save', then 'Browse' in the destination section to give your new file a meaningful name, eg. 'shuttle.mp3'. Choose 'Start' to begin the conversion.

6 CONVERT YOUR VIDEO

Click 'Save' to exit 'Profile Edition' and return to the 'Convert' window. In the 'Destination' section, click 'Browse'. Navigate to where you want to store the new video, and set a meaningful file name with the new container extension, eg. 'Squirrel.mp4'.

» Click 'Save' to register these changes. You can now select 'Start' to begin the conversion process. The time this takes will depend on the length of the clip, codecs involved, and your device's graphics processing power.

» VLC will display a timer for the duration of the video clip to mark its progress. Once conversion is complete, go to the 'Media' menu and choose 'Open File' to play your new media. [**Image E**]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LAB NOTES

MY LAIRD, CONTRIBUTOR

SPACE MARINE
ALIENWARE

Accompanied by the awesome image quality are some early adopter niggles.

OLED isn't all upside

The new monitors are complicated

FOR WHAT SEEMED like forever, I waited for the first high-refresh 32-inch 4K OLED monitors to arrive. Well, now they have, and I've spent quality time with a couple of them, namely the Alienware 32 AW3225QF and Asus ROG Swift OLED PG32UCDM.

They both use Samsung's new 32-inch QD-OLED panel, albeit Alienware has gone with the curved option and the Asus is flat. LG's competing 32-inch 4K OLED tech is also incoming, but monitors using it haven't gone on sale yet. Anyway, after several weeks with both models, I've acquired some learnings, most notably that life is pretty sweet with a high-DPI OLED monitor, but it's also complicated as well.

It's sweet, because OLED with decent pixel density and good full-screen brightness is what I've been waiting for. I particularly liked the Alienware. It feels a bit punchier in HDR mode, and for once I appreciated the panel curve. I normally find it superfluous on 16:9 ratio, as opposed to an ultrawide monitor, where it benefits.

Whatever, the combination of OLED sizzle and speed plus 4K sharpness is to die for. However, there are some aspects that remind you that you're an early adopter. Both monitors come with three years of OLED burn-in cover, but you don't have to worry about burn-in with a traditional LCD monitor, or whether you should have 'Pixel Refresh' or 'Panel Refresh' enabled in the OSD menu for the best protection.

Nor do you have to contend with frequent pop-ups asking if it's okay to run one of those options in the middle of a game. While the HDR experience is stunning, it's also a bit of a palaver. The Alienware has no fewer than nine HDR presets to choose from.

Eventually, I found one that was great for bright outdoor game scenes, and a different one for indoor scenes. But switching between many of the modes resyncs the monitor with your PC, kicking you back to the desktop and sometimes crashing the game you're playing, which is a bore.

The point is, I really don't want to have to switch presets everytime the game scene changes from bright to dark. I definitely don't want to do that if it kicks me back to the desktop and crashes what ever I'm playing. So, yeah, these new 4K OLEDs look incredible. But life was so much simpler with a plain old SDR LCD panel, that's for sure.

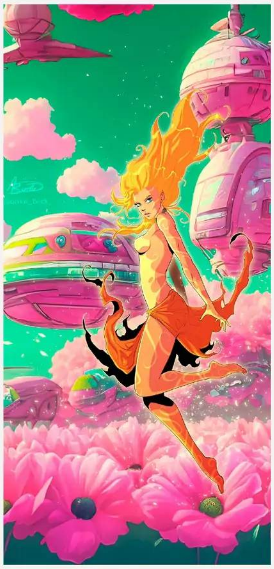
GUY COCKER,

Editor-in-Chief

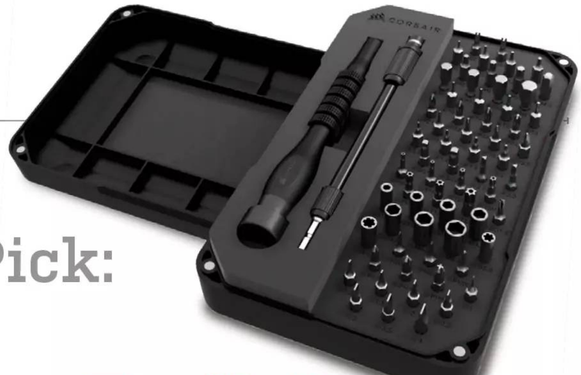
This month, I became a comic-book artist (of sorts, go with me on this) at the Adobe Max conference. Adobe was showing off the latest AI enhancements to its Creative Cloud of applications, namely Photoshop and Lightroom (you can learn about this for yourself by turning to our tutorial, which can be found on page 60).

The AI toolset, which Adobe terms 'Firefly', has become more accurate, powerful, and faster than ever before. In my honest opinion, it's probably the best implementation I've seen of AI in any software I regularly use, although that could be because I'm so terrible at photography and design that I need all the help I can get.

Anyway, comic-book artist Amrit Birdi (@amrit_birdi_) took one of his existing characters and was kind enough to let me design the background with just the aid of a text prompt, which I set as 'pink flowers and spaceships'. Okay, it's fair to say that clearly I'm no Frank Miller, but I think the results look pretty good.



© AI GENERATED BACKGROUND WITH AMRIT BIRDI IMAGE, ALIENWARE



You don't need a Corsair toolkit, but it is one of the best. Just make sure you have one.

Editor's Pick: Corsair Precision Toolkit

Or, why we could all learn a lot from coffee shops

I LEFT *Maximum PC* back in November of 2021. Corsair offered me a position as a PR specialist. I took the leap (this was before I realized just how much I'd miss journalism), thinking, given my skillset and ability to moan about products a lot, that maybe I could do some good there. I learnt a lot from my time there, and worked with some incredibly good people. There's a lot of talented folk in this industry, not just at Corsair, but Intel, AMD, Nvidia, Razer, Logitech, and more. It's a tight-knit community, and one I'm very fond of.

When I left Corsair in 2023, heading back into tech journalism and going freelance, the head of PR at the time and my manager gave me some incredible gifts. One was a bespoke Corsair flat cap (which I can never wear, for obvious reasons), a bottle of German mead (which I still haven't drank—emergency use only, please drink responsibly), and two, an early sample of the Corsair PC DIY Precision Toolkit, which was incredibly limited at the time.

Let me be clear, I am happy to wail on Corsair if it produces a bad product (seriously, why was the Xeneon Flex 3440x1440 on a 45-inch panel?), but this is fantastic. In fact, not only this kit, but any good-value precision toolkit. If you don't have one, get one ASAP.

An example of why it's so important? Well, right now, I freelance in the evenings, and during the day I work in a coffee shop as first barista. Each shot I pull has to have 18g of freshly ground coffee in the handle, be evenly distributed, tamped with 88lbs of force by a calibrated auto-tamper, and then run through the espresso machine, with a three-second pre-infusion (wetting the coffee puck), and poured into the cup in 30 seconds, at nine bars of pressure, with 197.6 F water running through it. That should result in roughly 36g of perfectly balanced espresso. If the grind is too fine, it'll run over, becoming too bitter. If the grind is too coarse, it'll run too quick, and the coffee will be too sharp—30 seconds is perfectly balanced, certainly for our house roast. Our coffee grinder is a Victoria Arduino Mythos One. It's a beast—second-hand, they cost around $1,800, and I constantly dial ours in and tweak it throughout the day to hit those figures. As the shop temperature, humidity, temperature of the grinder, temperature of the grounds, and age of the beans change, so do those times we're after.

Recently, our guest grinder started running really inconsistently. I had a hunch that it was because it was overheating due to the fans being clogged. It's like a PC. There's a mainboard in there, processor, big set of burrs to crush the coffee (admittedly not found in your average gaming rig), a heating element to keep the burrs at 55 C, and intake and exhaust fans to make sure it doesn't go above that during peak loads. There are all manner of screws, torx head keys, and allan bolts, all of which fell prey to my fantastic little precision toolkit. It's the same toolkit I used literally the day before, to build last month's 4080 Super rig. It's great, because I can take one toolkit with me everywhere. It doesn't matter if I'm repairing coffee machines, building PCs, or tinkering around the house, this one kit does it all. In this case, it saved us an engineer call-out, and I now know how to take apart and repair a Mythos One from top-to-bottom.

Corsair's kit here is very good. It has a great screwdriver, 65 attachments, and the lid has a magnetic plate in it that'll hold the screws a bit for you. It's cheap, too. **–ZS**
$34.99, www.corsair.com

© CORSAIR, SONY INTERACTIVE ENTERTAINMENT/ GUERRILLA GAMES

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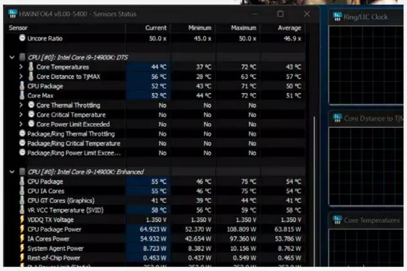
82 32GB Crucial Pro Overclocking DDR5
84 Geometric Future Model 8 Dharma
87 Elgato Facecam MK.2
88 ASUS ROG Strix Scope II RX

89 XGIMI Halo+



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Sensor                                   Current    Minimum    Maximum    Average
  Uncore Ratio                            50.0 x     45.0 x     50.0 x     46.9 x

v CPU [#0]: Intel Core i9-14900K: DTS
  > Core Temperatures                      44 °C      37 °C      72 °C      43 °C
  > Core Distance to TjMAX                 56 °C      28 °C      63 °C      57 °C
  CPU Package                              52 °C      43 °C      71 °C      50 °C
  Core Max                                 52 °C      44 °C      72 °C      51 °C
  > Core Thermal Throttling                   No         No         No
  > Core Critical Temperature                 No         No         No
  > Core Power Limit Exceeded                 No         No         No
  Package/Ring Thermal Throttling             No         No         No
  Package/Ring Critical Temperature           No         No         No
  Package/Ring Power Limit Excee...           No         No         No

v CPU [#0]: Intel Core i9-14900K: Enhanced
  CPU Package                              55 °C      46 °C      75 °C      54 °C
  CPU IA Cores                             55 °C      46 °C      75 °C      54 °C
  CPU GT Cores (Graphics)                  41 °C      39 °C      44 °C      41 °C
  VR VCC Temperature (SVID)                58 °C      56 °C      59 °C      58 °C
  VDDQ TX Voltage                         1.350 V    1.350 V    1.350 V    1.350 V
  CPU Package Power                      64.923 W   52.370 W  108.809 W   63.815 W
  IA Cores Power                         54.932 W   42.654 W   97.360 W   53.786 W
  System Agent Power                      8.723 W    8.382 W   10.156 W    8.762 W
  Rest-of-Chip Power                      0.453 W    0.437 W    0.549 W    0.465 W
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90 Horizon: Forbidden West
92 HWMonitor vs HWInfo

Sapphire RX 7900 GRE Pulse

The Golden Rabbit Edition goes global

WE ALL KNOW the story of the tortoise and the hare: the rabbit races along for short periods of time and then rests, while the turtle plods along at a steady pace and ultimately wins the race. AMD's RX 7900 GRE, the 'Golden Rabbit Edition' that was only available in China for the past year, flips the story around and claims a late victory by edging past its Nvidia competition in the form of the RTX 4070.

The 7900 GRE doesn't get a clear win in every area, however, and the RTX 4070 has been steadily racking up sales over the past year. It's the ninth most popular GPU right now, according to Valve's monthly Steam Hardware Survey. AMD could have launched the 7900 GRE in all markets last year, but at the time there were still a lot of previous-generation Navi 21-based GPUs in the channel, so it held off on introducing this third Navi 31 card until inventories had cleared.

Today, only the vanilla RX 6800 is still available at competitive prices, and even those cards are mostly fading away, so perhaps AMD's strategy worked. The problem is that in the interim, AMD had to fight for market share against a newer and more capable Nvidia GPU. For most gamers looking for a new $500+ card, the RTX 4070 was the only sensible choice.

Now, the Johnny-come-lately GRE has arrived, with a price adjustment relative to the original China release. Nvidia also launched its RTX 4070 Super and cut the price on the 4070. That gives us a direct head-to-head battle at the $550 price point.

Looking just at raw gaming performance, the 7900 GRE gets the win by three percent at 1440p and four percent at 4K. If you discount the three ray tracing games, however, the GRE's lead over the 4070 grows to 15–16 percent overall. That's an important change from the RX 7800 XT, which loses to the 4070 by a few percent overall, with only a 7–9 percent lead in the rasterization games.

Of course, it's not just about raw gaming performance. Nvidia still offers superior ray tracing and AI hardware, with the latter powering DLSS. FSR 2 and FSR 3 offer similar performance gains to DLSS, but image quality with AMD's FSR upscaling is clearly inferior. DLSS is also supported in more games, though the gap continues to narrow. Note that we're not including frame generation as part of this discussion, as the added latency and other drawbacks affect its usefulness in the real world.

The 4070 also uses about 70W less power overall, which potentially makes for a quieter PC. The reality is that noise levels depend more on specific card designs, and Sapphire's Pulse with its triple fans is exceptionally quiet. We measured just 36dB from a 10cm distance while playing demanding games, compared to 40dB on the 4070 Founders Edition. In other words, the specific card design matters more for noise than the GPU under the hood.

In a similar vein, card design from an add-in board partner also determines aesthetics. AMD doesn't offer a reference model RX 7900 GRE, but you can find various models from the usual suspects including Sapphire, ASRock, Asus, Gigabyte, PowerColor, and even Acer. The Sapphire Pulse is a barebones card in terms of aesthetics, so you won't get any RGB lighting. Some will say that's a good thing, but others like the bling. It doesn't have a dual BIOS switch either, if that's something you care about.

As the cards cross the finish line, the race between the 7900 GRE and RTX 4070 is about as close as it gets. Both are great options, depending on the specific needs and wants. AI and ray tracing generally benefit from the Nvidia card, while AMD's card offers more memory and faster rasterization performance. It would have been nice if AMD had offered this particular variant of the Navi 31 GPU last year, but better late than never.

–JARRED WALTON

BENCHMARKS

	RX 7900 GRE	RX 7800 XT	RTX 4070
10 Game Average	**78 / 43**	73 / 41	76 / 42
Assassin's Creed Mirage	**118** / 68	112 / **70**	113 / 68
Cyberpunk 2077 (DXR)	32 / 15	28 / 13	**38 / 17**
Flight Simulator	**81 / 52**	**81** / 46	79 / 41
Forza Horizon 5	**139 / 95**	127 / 85	119 / 82
Minecraft (DXR)	44 / 19	40 / 18	**68 / 31**
A Plague Tale: Requiem	**77 / 41**	68 / 39	65 / 35
Red Dead Redemption 2 (Vulkan)	**100 / 62**	92 / 59	84 / 53
Spider-Man: Miles Morales (DXR)	60 / **35**	59 / 34	**70 / 35**
The Last of Us, Part 1	**82 / 41**	77 / 39	70 / 36
Watch Dogs Legion	**119 / 66**	110 / 64	93 / 52

Best scores are in bold. All testing conducted with a Core i9-13900K, MSI MEG Z790 Ace, G.Skill 2x16GB DDR5-6600 CL34, 4TB Crucial T700, and be quiet! Dark Power Pro 12 1500W. Scores are average framerates at 2560x1440 / 4K ultra, with ray tracing enabled in Cyberpunk 2077, Minecraft, and Spider-Man: Miles Morales.

VERDICT

8

Sapphire RX 7900 GRE Pulse

➕ **HARE** Great performance; 16GB VRAM; Very quiet.

➖ **TORTOISE** Higher power use; No RGB; Weaker ray tracing.

$549, www.sapphiretech.com

SPECIFICATIONS

Architecture	Navi 31
Lithography	TSMC N5 + N6
Boost Clock	2293 MHz
GPU Cores	5120
Memory	16GB GDDR6
TFLOPS FP32	47.0
Bandwidth	576 GB/s
TBP	260W
Connectors	2x HDMI 2.1, 2x DP 2.1 54Gbps

PULSE
PULSE
PULSE
SAPPHIRE

CRYO CHAMBER
OMEN
GEFORCE RTX
45L
intel
CORE

The black case feels strong and solid, but you won't want to pick it up too often.

HP Omen 45L

HP's biggest desktop PC offers mighty gaming potential

HP'S CURRENT RANGE of Omen desktop cases are imposing black monoliths that genuinely do look like something out of a science fiction movie. We're referring to the type that's about unknowable alien technology indistinguishable from magic, rather than the affable uncle who makes an airship out of old gears and his wife's underwear, but sci-fi nonetheless. That it wears its CPU cooling system, known as a 'cryo chamber'—but actually just the usual radiator and fans—as a hat only enhances this feeling.

Luckily, the innards of the Omen 45L aren't fictional; they're functional. And with a 13th-gen i9, an RTX 4090 and 64GB of RAM, this one's very functional indeed. There may be newer chips emerging onto the market, but the i9-13900K is not to be argued with, and matched with the RTX 4090, it becomes a dominant combination for 4K gaming or the creative arts—high-res video editing or Lightroom's AI noise reduction are no bother with this kind of processing power on board.

But back to that case. You're going to have to look at this thing every day if you set it up in your gaming space, so it's a good thing it's rather handsome. While it ticks all the usual boxes of having a window in the side so you can see everything within not moving about, there's also a lot of lighting. It's on the CPU cooler pump, the tops of the RAM sticks, GPU, and the very ceiling of the case itself. There's also a diamond-shaped Omen logo on the front which lights up, along with three fans which, you've guessed it, emit bright rainbow hues. All of this is controlled by the HP Omen Gaming Hub, meaning you can have solid colors or turn it off if the pulsing becomes too much.

Our review model has a slightly untidy interior, with some cabling that could have been tucked further out of sight, and a visibly empty SSD slot. This makes the inclusion of a 2TB hard drive as the secondary storage even more infuriating. At this price, HP shouldn't be cutting corners like that. It's hardly the end of the world, and spinning drives do still have their place as silos to store backups and archives, but the open M.2 slot, with its label advising only SSDs with heat sinks be used, makes us wonder how many people will be happy buying a PC like this that they're going to want to upgrade.

Still, they're not going to be upset by its performance. Frame rates are huge, 4K Ultra settings are laughed at, and the cooling system takes everything in its stride. There's a hum from the machine, and you'll know when it's doing something, because the sound of the fans increases a little, but that Cryo Chamber cooler (really an AIO built into the case) does an excellent job, as well as providing somewhere to get a grip when you're trying to move it. At almost 50lbs, it's still possible to carry, but we wouldn't want to have to heave it up an apartment block.

HP has done well. Not only is it well specced—and even newer 14th-gen Intel chips should be along by the time you read this—it's been built into a case that has the space, airflow, and cooling to make it worthwhile. There's plenty of I/O, too, though Thunderbolt is lacking from our review model, and if you're looking for something that can handle heavy gaming or creative video and 3D work, then it won't disappoint. **–IAN EVENDEN**

VERDICT

9

HP Omen 45L

⊞ **THE OMEN (1976)** Hugely powerful; Well built for gaming and other pursuits.

⊟ **THE OMEN (2006)** Expensive; Still packing a spinning hard drive.

$4,400, www.omen.com

SPECIFICATIONS

CPU	Intel Core i9 i9-13900K
GPU	Nvidia GeForce RTX 4090
RAM	64GB DDR5
Storage	1TB SSD, 2TB HDD
Connectivity	Wi-Fi 6E, Bluetooth 5.3, Ethernet, 1x USB 3 Type-C 10Gbps, 1x USB 3 Type-C 5Gbps, 2x USB 3 Type A 10Gbps, 4x USB 3 Type-A 5Gbps, 4x USB 2 Type-A, audio in, audio out, microphone, 1x HDMI, 3x DisplayPort
Dimensions	8.3 x 18.5 x 21.8 in
Weight	49.8lbs

Ayaneo Kun

Physically wonderful, technically impressive, frustratingly quirky

IS THE AYANEO KUN the king of handheld gaming PCs? That's what the company is clearly aiming for with a name like that, and it gets so damned close. Yet, there are the little things that get in the way of the full regal verdict.

Hold that thought—the Ayaneo Kun is based on the exact same silicon as most other gaming handhelds. Yup, it's the AMD Ryzen 7 7840U (occasionally known as the Ryzen Z1 Extreme), and it's the SoC de jour, paired here with 32GB of RAM and a 2TB SSD. It's a huge amount of hardware for a handheld.

Ayaneo itself has a host of different devices, from the tiny Air 1S to its Flip in two different designs, and the Slide. The Kun is perhaps the most traditional of the lot, but it has its own claims to innovation, the unique 54W mode on its 30W APU being one of them. It's also very big, with a large 8.4-inch screen, though in a Steam Deck-y way it still feels good in the hand.

It's also the only handheld so far to pick up Valve's use of twin trackpads and run with it. The size of the Kun means it can get away with using two pads, one below the left D-pad and the other under the right-hand thumbstick. At first they seem all kinds of unusable, but a recent update has made the trackpads far more responsive and much more like the sort of pad you'd find on a laptop. Just, you know, really small.

When you're using a Windows-based handheld they come in very handy just for ease of navigation in those awkward launchers that resolutely adhere to the idea that if you're playing a PC game then you're going to be using a mouse as your primary input, no matter what.

Ayaneo has jammed a hefty battery into the Kun, too. That means we're able to get within a whisker of two hours in the PCMark 10 gaming battery life test, even running the machine at 30W. As for gaming performance, however, we were hoping for a bit more. Ayaneo has made a lot out of its cooling and its mega 54W TDP limits. It's up there for sure, and optimizing the game settings will get you impressive 1080p gaming performance—and very occasionally passable 1440p frame rates—but never the outright best in the handheld category.

Where it is best, however, is in the config software, even compared with the integration Valve has between SteamOS and Deck. That allows you to tailor your experience, depending on what you're playing, in order to squeeze as much battery life out of the Kun as possible while enjoying a healthy frame rate.

If you want to lean on that AMD APU, then leave it at 30W and push the Radeon 780M graphics chip to its maximum, but if you're bounding around the Sword Coast via GeForce Now, you can drop it down to 5W TDP and have the battery last for an age, though if you want the absolute full power of the AMD APU, Ayaneo gives you that 54W mode, which we cannot in all good conscience recommend. It positively hoses through your battery, and yet barely adds any performance.

Then there's the D-pad. It's so sticky that Ayaneo has had to issue a fix because of "a manufacturing defect in the gasket." That necessitates stripping down your device to get at the back of the D-pad. Also, while the 2,560 x 1,600 screen is very bright, there is a certain lack of color to it. It's also just a 60Hz panel.

It's those little frustrations, and the disappointing 54W mode, that make it hard to give this a strong buy recommendation. It's still a great device, with absolutely the best Windows software of any handheld around. However, for this kind of money, it needs to be almost perfect—and it's just not. **–DAVE JAMES**

VERDICT

8

Ayaneo Kun

➕ **SIZE MATTERS** Large, High-res screen; Great control software.

➖ **OVERWEIGHT** Very expensive; Sticky D-pad; 54W mode disappoints.

$1,329, www.ayaneo.com

BENCHMARKS

	Ayaneo Kun	OneXPlayer 2 Pro	Asus ROG Ally
Cyberpunk 2077 1080p (fps)*	**44**	**44**	37
Horizon Zero Dawn 1080p (fps)*	49	48	**66**
Metro Exodus Enhanced 1080p (fps)*	18	**23**	21
Battery life (mins)	**119**	101	57

Best scores are in bold. * All games tested using FSR upscaling to 1080p

SPECIFICATIONS

APU	AMD Ryzen 7 7840U
iGPU	Radeon 780M
Memory	32GB LPDDR5-7500
Storage	2TB SSD
Screen	8-inch IPS
Resolution	2,560 x 1,600
Battery	75Wh

With 8 cores, 16 threads, and 32GB RAM, this is one powerful handheld PC.

2TB Seagate FireCuda 540 PCIe 5.0 M.2 SSD

A brilliant drive, wrongly priced

ARE YOU READY for a really bad joke? There's not a single Cuda core on this thing—not one—and it's not on fire, either. What the heck, Seagate? You had one job: give your PCIe 5.0 drive a sensible name. Well folks, here we have it: Seagate's top-tier, flagship PCIe 5.0 drive that you can pick up right now. It's not quite as blisteringly quick as some of its like-minded competitors, at least not on the sequentials, but it is nippy in other areas. Let's dive in.

The FireCuda 540 is pretty similar to a number of 5.0 drives out there right now. In fact, it's genuinely quite sad just how similar all these drives are. At its heart, the 540 features a 232-layer TLC NAND developed by Micron, Phison's E26 PCIe 5.0 controller, and an LPDDR4 DRAM cache as well, all baked into the M.2 2280 form-factor. One key difference, however, lies in the warranty, and that's the fact this comes with an endurance rating of 2000 TBW, which is actually 600 TB more than the next best PCIe 5.0 SSD we've tested, the Gigabyte Aorus Gen5 12000. You still get the five year warranty as well, of course, but having that extra 600 TB is nothing to sniff at. But yes, otherwise, it's entirely the same componentry as the Aorus Gen5, Crucial T700, and T705.

DRIVING PERFORMANCE

One major change, and perhaps a more painful one, is the price. Actually, that's something we should talk about across the board. When we first requested these drives, prices started at $240 for the Gigabyte, $270 for the FireCuda, and $270 for the Crucial T700. Now, the FireCuda lands at a spectacularly depressing $310, $270 for the Gigabyte, and $280 for the Crucial T700. This slow creep in pricing is, we're guessing, down to storage chips being snapped up for AI and accelerated learning systems, as has been widely reported in the industry. It's likely that PCIe 5.0 drives are going to become more expensive moving forward. Sadly, that's the pricing for the heatsink-less versions too, not the heatsinked ones, although the FireCuda 540 lacks a heatsink variant, anyway.

Pricing conundrums aside, when it comes to performance, the FireCuda 540 does surprisingly well across the board. Sequentials are lower than our competing drives, clocking in at around 10GB/s for both read and write at QD32, (and lower in AS SSD, as you'd expect), but for the random 4K performance, we're seeing very similar performance to the T705 and the Aorus Gen5 12000, with the 540 clocking in a respectable 85.55 and 272.45 MB/s in AS SSD's random 4K test. More impressive, however, was its 4K QD1 performance in CrystalDiskMark, with it actually beating both the Aorus Gen5 12000 and the T705 to the punch, with a phenomenal 321 MB/s read speed at a queue depth of 1.

One of the more impressive things Seagate includes with its drives is access to its own bespoke Rescue Data Recovery Services. This is certainly a bit more niche, but if you have critical business data or personal data on these things, and it's damaged in any way from floods, fires, or another form of natural disaster or water damage, Seagate's team of dedicated experts will do their best to extract as much data from it as possible. Plus, it's all included as standard, at least for the first three years.

So then, what do we make of the FireCuda 540? Well, bad names (and jokes) aside, and excusing the price hike, it's a well-rounded, robust PCIe 5.0 drive. It's not got the fastest sequential speeds, but that doesn't hold it back where it counts, random 4K performance. Pick one of these up today, and you'll be happy for many years to come. **–ZAK STOREY**

VERDICT **9**

2TB Seagate FireCuda 540 PCIe 5.0 M.2 SSD

➕ **FIRE ALL THE GUNS** Well-rounded performance; Phenomenal endurance; Data recovery inclusion is an epic plus.

➖ **REALLY BAD PUNS** Pricing is high; Sequentials slightly low.

$310, www.seagate.com

BENCHMARKS

	2TB Seagate FireCuda 540 PCIe 5.0 M.2 SSD	2TB Crucial T705 PCIe 5.0 M.2 SSD	2TB Gigabyte Aorus Gen5 12000 PCIe 5.0 M.2 SSD
AS SSD Sequential - Read / Write (MB/s)	7,324 / 6,796	**10,064 / 9,627**	8,970 / 9,948
AS SSD Random 4K - Read / Write (MB/s)	85.55 / 272.45	84.50 / 273.12	**86.65 / 289.12**
AS SSD Access Time (ms)	0.017 / 0.051	**0.015** / 0.045	0.017 / **0.037**
CrystalDiskMark Sequential QD32 Read / Write (MB/s)	10,125 / 10,211	**14,027 / 12,280**	12,353 / 11,598
CrystalDiskMark Random 4KQ1 Read / Write (MB/s)	**89 / 321**	86 / 303	**89** / 310
Max Temp Under Load (C)	75	**74**	78
Gigabyte per $ (GB)	6.45	7.09	**7.41**
Sequential Read MB/s per $ (MB/s)	32.66	**49.74**	45.75

Best scores in bold. Our test bed consists of an Intel Core i9-14900K, 32GB of Corsair Dominator Titanium @ 7200, an Nvidia GeForce RTX 4080, Corsair H150i AIO, and an Asus Z790 Dark Hero. Max Temp recorded via HWMonitor during benchmarking process.

SPECIFICATIONS

Variants	Stock Only
Form Factor	M.2 2280
Interface / Protocol	PCIe 5.0 / NVMe
Flash Memory	232-Layer TLC NAND Flash
Sequential Read	10,000 MB/s
Sequential Write	10,000 MB/s
Random Read	1490K IOPS
Random Write	1500K IOPS
Endurance (TBW)	2,000
Warranty	5 Years Limited Warranty

Q020026CE000002G
FIRECUDA™
540 Series
SEAGATE
PCIe Gen5 SSD

Not a CUDA core in sight….

32GB Crucial Pro Overclocking DDR5

No glitz, no glamor; all performance

FOR THE LONGEST TIME, two of the biggest names in the memory market have been Corsair and Crucial (or Micron, really). They're without a doubt some of the largest manufacturers out there, with some serious market share both on the enterprise level and to us consumers as well.

Corsair has perhaps made itself more prominently known on that front, particularly with its Dominator and Vengeance series (although Crucial certainly has tried in the past with its Ballistix line), but all in all, these two juggernauts have been at it for many, many years, battling to and fro over ever-tightening market-share. Why is that relevant? Well, let's just say that when it comes to performance, these two are the kings, and our memory kit on test today, Crucial's Pro Overclocking, really does represent that better than any other kit Crucial has on the market.

At first glance, it's not that exciting; just another 32GB 6,000 MT/s kit. There's no glitz, glamor, or ridiculously over-the-top RGB lighting; just pure black sticks of memory, with a slim form factor, and little in the way of a heatsink. Heck, even those top-line stats are relatively subdued—6,000 MT/s is hardly much to write home about, and with a CAS36 latency, real-world latency plods around at a positively sluggish 12ns, certainly far slower than our Corsair Dominator Titanium's 9.44 ns, or even Adata's Lancer XPG Blade's 10 ns. So what gives?

Namely, the price and compatibility. You can pick up this 32GB kit right now for $105. Yeah, that low—it's ridiculous, if we're honest. Not only that, but this 6,000 MT/s kit not only works in our Intel test bed, complete with two sets of XMP timings (one at 6000 and one at 5600), but it also has identical profiles up and ready to go for AMD's EXPO profiles, too. That's five total profiles including the standard JEDEC one as well.

It's seriously low, too, measuring less than 1.5 inches tall, making it a sound pick if you've got an unruly air cooler, or just fancy something a little slicker than your average RGB-illuminated 'gamer' memory, which tends to stand tall from your motherboard.

Performance is pretty much where we'd expect with a 6,000 MT/s kit. It scored a comfortable 78ns in SiSoftSandra's latency test—slightly faster than the XPG kit, and slower than the Titanium kit. Memory bandwidth topped out at 73 GB/s versus the XPG's 69 and the Titanium's 80, and max temperature landed on 51C—identical to the Lancer Blade, too.

As per usual, in-game performance varied very little between our three memory kits, with identical *Total War Warhammer III* average frame rates, and a slight variance on the minimum, but well within margin of error.

So what's not to like? Well, if we're honest, there's little to complain about here. It's super low-profile, performed incredibly well in our testing suite, and comes in at a phenomenal price. Couple that with some epic compatibility across both AMD and Intel CPUs, and you're on to a winner. **–ZAK STOREY**

BENCHMARKS

	32GB (2x16GB) Crucial Pro Overclocking DDR5 @ 6000 MT/s	32GB (2x16GB) Corsair Dominator Titanium DDR5 @ 7200 MT/s	32GB (2x16GB) XPG Lancer Blade RGB DDR5 @ 6000 MT/s
SiSoftSandra Overall Memory Score (Index / kPT)	**2.68**	2.49	2.27
SiSoftSandra Memory Latency (ns)	78	**73**	80
SiSoftSandra Memory Bandwidth (GB/s)	73	**80**	69
PCMark10 - Express (Index)	6,852	**7,162**	6,624
10GB WinRAR Archive Time (Seconds)	116	**115**	116
Puget Bench - Adobe Photoshop (Index)	7,532	**8,150**	7,550
Total War: Warhammer III (avg / min fps)	**191.3 / 148**	**191.3 / 148**	**191.3** / 147
Max Temp Under Load (Celsius)	51.0	**43.5**	051.0
Real World Latency (ns)	12.00	**9.44**	10.00
Gigabyte per $ (Index)	**0.30**	0.15	**0.30**

Best scores in bold. Our test bed consists of an Intel Core i5-14600K, Asus Z790 Dark Hero motherboard, an Nvidia GeForce RTX 4080, Corsair H150i AIO, and an Adata Legend 960 Max PCIe 4.0 SSD. All gaming tests were performed at 1080p, on the highest preset. XMP is enabled.

VERDICT
9
KICK ASS!

32GB Crucial Pro Overclocking DDR5

+ OVERCLOCKED TO THE 9S Quick; AMD and Intel-compatible; Super-low profile; The price is brilliant.

− JEDEC WOULD LIKE A WORD Real-world latency could be a little tighter.

$105, www.crucial.com

SPECIFICATIONS

Capacity	32GB (2x16GB)
Channels	Dual
DDR Standard	DDR5
Frequency	6,000 MT/s
CAS Latency	36
Operating Voltage	1.45V
Warranty	Limited Lifetime

Crucial's subdued look hides some seriously slick performance.

GEOMETRIC FUTURE

You can pick this up in all manner of styles, including knitted aviation grade fabric, Mexican blanket version. No, seriously.

Geometric Future Model 8 Dharma

Something a little different

THERE'S SOMETHING TO be said for a chassis design that's a little different. No matter where you turn these days, pretty much all cases look sort of the same. Let's be fair, there's only so much you can do with a metal box that holds your PC parts, but still, the homogenization of the humble chassis is a little disappointing, particularly if you want something a little more unique.

The Model 8 from Geometric Future does exactly that. It's made by a small start-up Chinese company. It's got a few products out there: the odd power supply, liquid-cooler, fan, you know the drill, but the big product range comes in the form of its chassis.

Yep, there are four base versions total, all of them labeled as 'Models' going from 2 to 8, and each comes with an incredibly unique array of different styles to choose from. It's not just, 'you can get this case in black and/or white', but there are fabric variants, multi-colored versions, mirrored solutions, a leather one—you name it, they probably do it.

The Model 8 is the biggest of the lot. It's the chassis we used in last issue's cover build, and is built with SSI-EEB and EATX boards in mind. Internally, the big change is the entire motherboard area being rotated by 90 degrees, giving you a very unique interior, with all of your rear I/O located in the roof, hidden by a top mesh, and a good two inches of space up top.

As standard, there's a ton of support for liquid cooling. You can fit up to a 420mm radiator in the back and a 360mm radiator in the floor, with fans supporting. If you go the AIO route, you can fit a 360mm in the rear, and up to four 120mm fans on the bottom with a touch of modding (you can read more about that in our cooling feature, also last issue).

Overall chassis dimensions are solid, too. It's 500 x 500mm tall and long, and around 230mm deep, giving it a relatively small footprint. Geometric has managed this by how its configured both the cable management and that PSU shroud to be incredibly space-saving without compromising on cable management.

On the whole, for the price, it's impressive. The only downside is exactly that, cable management. There's a lack of cable tie-off points, any form of channeling, or even covers, to stop any cables you do have, from popping through the cable holes going to the motherboard. There's no rubber grommets here either. It helps if you buy some cable clips from Amazon and stick them in. That said, with a bit of ingenuity, you can build an incredibly crisp-looking system.

The big selling point, however, is that rotated internal design. Not only is it incredibly unique in contrast to the vast majority of cases on the market, but it also encourages better airflow by channeling the heat straight up and out of the case itself. With three or four fans in the floor, channeling cool air straight up and directly into the GPU, along with that rear intake being perfect for an AIO, you don't have to compromise on having a hot AIO and a cool GPU, or a hot GPU and a cool AIO.

So is it a good case? Yes. It has its flaws, but for the price and what it represents, it's a fantastic option for anyone looking at picking up a compact yet potent chassis. All it needs is a little love or a 2.0 revision, and this thing will be the absolute king of mid-tower cases. **–ZAK STOREY**

VERDICT

9

Geometric Future Model 8 Dharma

+ PYTHAGOREAN Unique internal layout; Multitude of interesting finishes; Great cooling; Impressive footprint, given the internals.

− ROUND PEG, SQUARE HOLE Cable management needs major work; Can technically support four 120mm in the floor.

$130, www.geometricfuture.com

SPECIFICATIONS

Motherboard Support	ITX, Micro-ATX, ATX, E-ATX (12x13 inches)
2.5-inch / 3.5-inch Support	6x 2.5 inch / 3x 3.5 inch + 3x 2.5 inch
Max Radiator Support	420mm Rear, 360mm Floor, 120mm Roof
Fan Support	3x 120/140mm Rear, 3x 120/140mm Floor, 1x 120mm Roof
Dimensions	19.7 x 19.7 x 9.1 inches
Graphics Card Clearance	16.0 inches
CPU Tower Clearance	6.69 inches
Warranty	1 Year

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Elgato Facecam MK.2

Don't call it a sequel—it's an upgrade in every way

1080p60 HDR 24mm f/2.4
FACECAM

WE WEREN'T EXPECTING much from the new Elgato Facecam MK.2. It's not a sequel, but it will go on to replace the existing Facecam we loved so well. It's also a bit cheaper than the original camera's launch price: the new one starts at $150, while the MK.1 debuted at $200.

But it's great. Really great. Pretty much a better webcam than the first in every aspect, and we are massively digging the new HDR mode the Facecam MK.2 employs. In my home office space, with a couple of bright windows facing the side of my screen, it's ace not having those utterly blowing out the image every time I jump on a call in the daytime.

It's not messing around trying to be some 4K monster of a cam, but what the Facecam has always offered is a fantastic uncompressed 1080p stream.

Given the target audience for Elgato gear is the streaming market, that choice is a smart one. To that end, the MK.2 again offers 1080p60 uncompressed, with 720p120 included in a host of other resolutions and frame rates lower down the scale.

HOW IT'S EVOLVED

The new Facecam is using the same Sony STARVIS CMOS sensor, and still delivers a great picture, despite the MK.2 having a noticeably smaller 'eye' compared with the first model, making the camera far smaller as a whole.

It's more the change in how the Facecam connects to the stand that has been improved. The original still just screwed on, but in a way that meant it always had to be a little too loose to be able to face forward or be moved around to face you. The new version is still pretty basic, but the simple screw mechanism now allows you to shift the camera around more freely, and also stops it standing too proud atop your monitor. Elgato has also integrated the privacy shield into the device now. It's another low-tech solution, with just a sliding screen that you can pull across, but it works.

Elgato is very up front about the fact that the HDR mode does not automatically make everything look better, and that it will depend on your setup.

Elgato's software is some of the best around, and links in happily with Nvidia's Broadcast software, too. There are a host of different controls available, which enable you to tailor the image to your personal tastes. There are other additions to the MK.2 surfaced by the Camera Hub software, too, with the zoom, pan, and tilt options allowing you to bring the image in tighter around you if the 82-degree FoV is too wide for your tastes.

Something that has stayed the same is the lack of auto focus. The focus length of 30cm to 110cm means that you're not going to get that annoying experience of a webcam constantly battling to figure out what it should be focusing on.

We're running an Intel Arc A770 on our office PC, and Elgato requires an Nvidia RTX 2060 or greater to give you access to a lot of the advanced features, which also means that AMD GPU owners will be left out in the cold.

But this camera is now our go-to camera for home use, because it's clearly delivering an image beyond what the original Facecam MK.1 can, even in darker environments. Moreover, it's doing it all in a more effective and less awkward package, too. So while Elgato might hold that this is not a true sequel to the Facecam, it's nevertheless an improvement on all fronts.

Elgato's second webcam supposedly isn't a sequel to the original Facecam, but it has effortlessly improved on the few problems we had with the MK.1 to deliver an outstanding webcam that deserves to be a hit for streamers and everyone else. We can't wait to see what it has planned for a proper Facecam 2. **–DAVE JAMES**

VERDICT

9

Elgato Facecam MK.2

⊞ **FACE IT** HDR image is excellent; Uncompressed 1080p60 and 720p120; Fixed focus; Software is outstanding; Smart new design.

⊟ **TURN AROUND** Privacy shield is fiddly; Requires Nvidia GPU for some bells and whistles.

$150, www.elgato.com

SPECIFICATIONS

Supported resolutions	1080p60, 1080p30, 720p120, 720p60, 720p30, 540p120, 540p, 60, 540p30
Optics	Elgato Prime Lens
Focus	Fixed (30 - 120cm)
Field of view	84°
Sensor	Sony STARVIS
Connection	USB Type-C
Dimensions	84 x 38 x 61mm

ASUS ROG Strix Scope II RX

Clickety clackety class

MECHANICAL KEYBOARDS for the average Joe are a bit unique these days. Because the market and the enthusiast space has advanced so rapidly over the last few years, long gone are the times when manufacturers could forgo sound-dampening, and use any old Cherry switch or a discounted alternative on their boards. After all, why buy an off-the-shelf product when you can build a board specifically for your needs? Layout size, switch-type, foam dampening, keycaps, cable—all of it can be customized to your liking. That puts the traditional manufacturers in a tricky position when it comes to designing new product lines, and it's very much a case of 'adapt or die'.

Asus, while not new to the peripheral game, is certainly not a brand that immediately springs to mind when you think of this category. Logitech, SteelSeries, Corsair, and Razer have all had the bulk of the market tied down for some time now. Yet, that's what's given Asus a bit of an edge, and the opportunity to take that mantra we mentioned earlier and truly innovate, building a line of products that genuinely take the keyboard game (and wider peripherals for that matter) to the next level. None less so than the Asus ROG Strix Scope II RX we have here today.

Firstly, yes, the name is a little ridiculous and mildly confusing. However, this is a full-sized keyboard available for just $140, complete with sound-dampened optical switches, and, if we're honest, some incredible style chops, too.

It's a simple enough design, with a brushed metal top-plate, some incredibly smooth optical linear, pre-lubed key switches (and a tactile RX Blue variant available as well), all of which are paired with solid RGB lighting, removable USB C cable, and a wrist-rest as well. Asus also includes an alternative space bar, rich with a pixelated ROG logo, allowing more of that light to shine through. It's also IP57-rated, to protect against any minor spells and dust build-up. More impressively, it features a layer of sound-dampening foam to mute unwanted pings and clangs as springs reset.

KEYED IN

Using it in-game, or even just typing (particularly the linear variant) is an absolute joy. The keys are super-quick to actuate and smooth on the downpress before bouncing right back up. If you like bottoming out each switch with every click, you'll be glad to know that hammering away at the Scope II RX is one of the most satisfying typing experiences you can have. The switches themselves have a 1ms response time thanks to that optical interface, and are rated up to 100 million key clicks until failure (at least according to Asus).

One other nice feature is that much-needed volume scroll wheel at the top-right of the board. Although, it does more than just volume; the big ol' button next to it actually cycles through four separate modes, allowing you to also control media playback (skipping and pausing songs), keyboard brightness, and even dedicate macros to it as well. This is one well thought-out board.

It's not without its flaws—you do have to install the Asus Armory app to use it, and that's still a jarring experience at times. It's slow and laggy, often failing to load entirely on our test system. But once you're in there and have configured your board and its lighting once, you really don't need to go back into it, thankfully.

This is one hell of a keyboard. Its clean design, paired with a fantastic key-switch and a super impressive price point and feature list makes it one of the best mechanical boards out there right now. Particularly if you're a fan of the full-sized units. **–ZAK STOREY**

VERDICT **9** KICK ASS!

ASUS ROG Strix Scope II RX

+ I CAN SEE FOR MILES Super clean design; Great price point; Epic key switch; solid feature list; Awesome sound-dampening.

− ...AND MILES AND MILES. Armory Crate

$140, www.asus.com

SPECIFICATIONS

Layout	Full-size
Switch Type	Optical
Switches	RX Red, RX Blue
Backlighting	Yes
Anti-ghosting	Yes
N-Key Rollover	Yes
Discrete Media Keys	Sort of
Connection	USB-C to USB-A
Weight	836g / 1.84 lbs

XGIMI Halo+

Almost flawless projection—with a catch

XGIMI MIGHT NOT HOLD the same amount of clout as some of the other big projector brands out there, but when one of our colleagues offered us a chance to take a look at its latest portable projector for review, a quick glance at the product page quickly convinced us to take the plunge. Tat's right—this is a portable 1080p projector, with HDR10, coming in at $850 or so (although you can currently grab one for around $650 on offer).

At first glance, it's not exactly a super-exciting product. It's just 1080p after all. A quick look around the back reveals very little in the way of rear I/O too. There's an (eARC supported) HDMI port, one headphone jack for 3.5mm audio, a DC power connector, a USB port, and, well, that's it. It's a far cry from some of the more premium units out there.

It's only when you start to take a look at the feature list that the Halo+ comes into its own. Given that it's, you know, portable, creating a perfect setup each and every time is something that's likely more of a pipe dream, certainly for a traditional projector. The Halo+, however, circumvents a lot of those problems with an incredible array of features, designed to eliminate the faff involved with getting everything aligned each time.

As standard, it comes with auto-focus, auto-keystone correction, intelligent screen alignment, and obstacle avoidance. You can shine this on a hallway wall, and it will actively adjust the angle of the projection lens to avoid any hanging pictures. It will analyze the angle you've placed it at, and the wall it's projecting onto, then pivot the image so it lines up square. It will then auto-focus that clearly, and adjust the keystone accordingly. The speed at which it does all of that is just phenomenal. You can, of course, still adjust all of these settings manually, but the fact that it does this ad-hoc, as soon as you set up and power it on in a new room, is awesome.

On top of that, it comes with Android TV as standard. Setup is glorious, and if you're running an Android phone, you can quickly set up and pull all the Wi-Fi data and Google logins you need over, making it a seamless process. There's a ton of apps on there, too, although they do vary depending on your region.

THE COMPLETE PACKAGE?

Fun convenience features aside, then, the big question remains. Image quality—is it any good? The short answer is, yes. By default, the Halo+ is capable of driving an image at around 700 lumens or so, which isn't bad at all. We actually tested this out in a number of places before projecting it onto a screen, including a dark gray wall, and were pleasantly surprised about just how rich the colors and brightness were, even on unsuitable surfaces. On any white area, however, it's much more vibrant. It also has HDR10 support as well, and you can really tell. Compared to something like Acer's GD711, this thing absolutely dominates on the color accuracy front.

It's not without its flaws, however. Although it's great when it comes to general projection for movies, television, and streaming (and the built-in speakers are surprisingly potent), when it comes to gaming, particularly over HDMI, the lag is horrendous. We're talking a good half a second before that mouse cursor moves, or the button press is registered.

You know what, though? We can let that slide. This isn't a gaming projector, and it's not marketed as one; it's just an incredibly potent, portable, powerhouse of a budget projection unit, and kicks some serious ass. If you want something with a bit more punch for gaming, then Acer's Predator line or Benq's X500i might be a better fit, but for everything else, the Halo+ is a titan. **–ZAK STOREY**

VERDICT
9
KICK ASS!

XGIMI Halo+

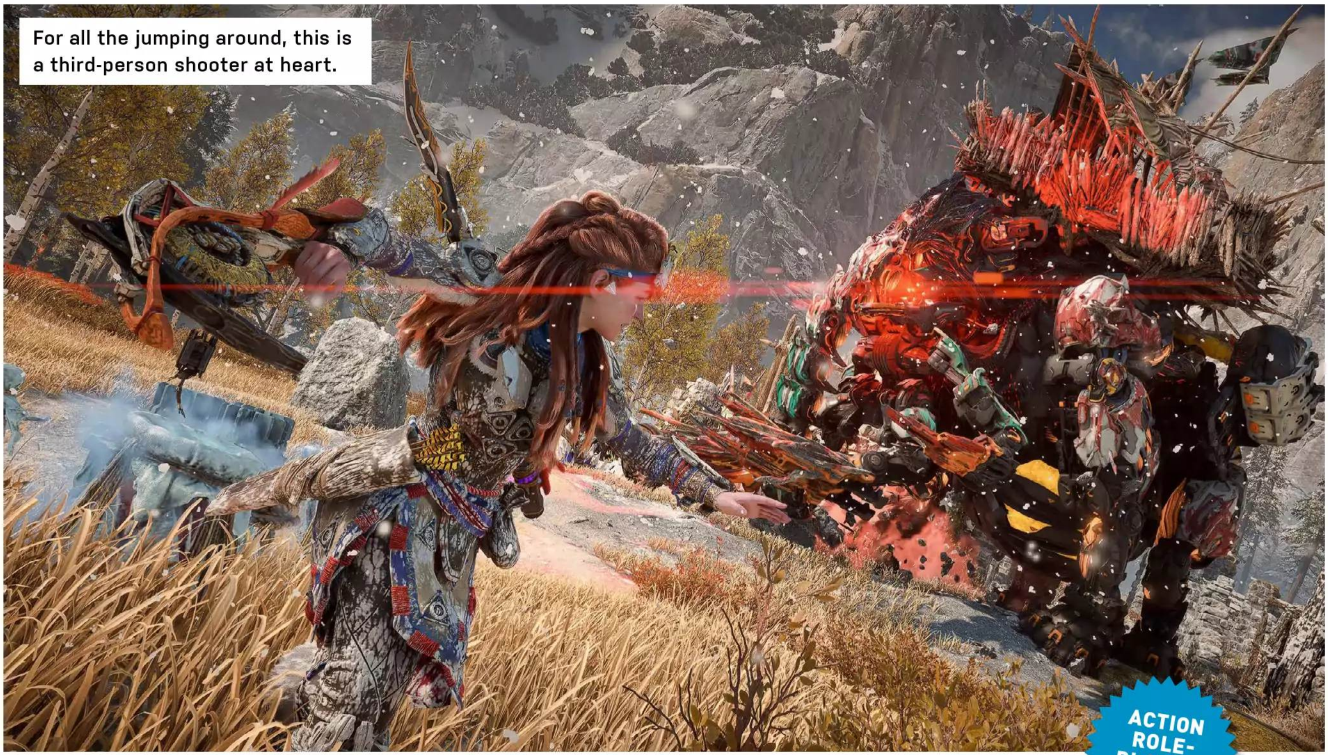
➕ **MASTER CHIEF** Incredible picture quality; Super easy to use; Awesome audio; Great price; Portable.

➖ **HALO RINGS** Significant lag in gaming.

$700, www.xgimi.com

SPECIFICATIONS

Resolutions	1080p
Brightness	700 ISO Lumens
Light Source Life	25,000
Max Screen Size	200"
Throw Ratio	1.2:1
Battery Life	2.5 Hours
Dimensions	6.77 x 4.49 x 5.71 inches
Connectivity	1x HDMI, 1x USB, 1x 3.5mm Audio, WiFi 802.11a/b/g/n/ac, Bluetooth 5.0/BLE



For all the jumping around, this is a third-person shooter at heart.

ACTION ROLE-PLAYING GAME

Horizon: Forbidden West

A solid PC port job, but doesn't move the series forward

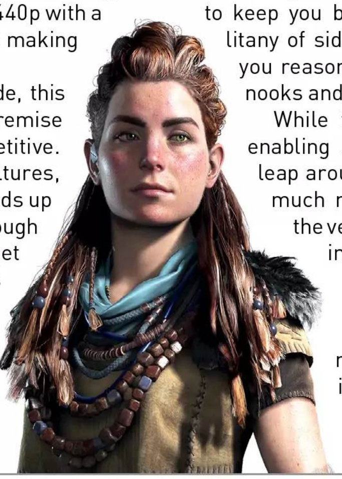
WOW. Look at those swaying aquatic plants as you dive underwater, ready to hide from mechanical foes in the 'stealth kelp'. Look at the neon lights that form the cyber-ghost of Las Vegas above the post-apocalyptic dunes, and the lush grass as you stoop down to slowly pick up more sticks. No question, *Horizon: Forbidden West* is a technical tour de force.

But while the graphics have certainly evolved, arguably little else has. The gorgeous visuals at least make this feel at home on PC. With a good enough rig, this port can meet and exceed what is still one of PS5's most resource-hungry titles. That said, on our mid-level test rig, the game ran very nicely at 1440p with a 144hz refresh, Nvidia's DLSS making the graphics a treat on High.

Performance matters aside, this game's initially intriguing premise quickly begins to feel repetitive. Somehow, a new land, cultures, and cast of characters still ends up feeling like a game going through the motions. It's harder to get behind the main character's quest here, too. Aloy seems world-weary to a deflating degree. If she's not invested anymore, why should I be? Then there's the game's underwhelming tutorial questline, which is essentially about breaking up a union work stoppage.

Allies from the more engaging first game do return, but Aloy's abrasiveness in this instalment means you don't spend as much time with them as you'd like. It's especially frustrating as Varl, one of the best and most underutilized characters from the first game, is constantly pushed aside.

Once unleashed into the wide-open world, you'll find that everything is structured very similarly to the first game. There's a legion of checklist activities to keep you busy, and of course, a litany of side-quests, often giving you reason to explore the map's nooks and crannies.



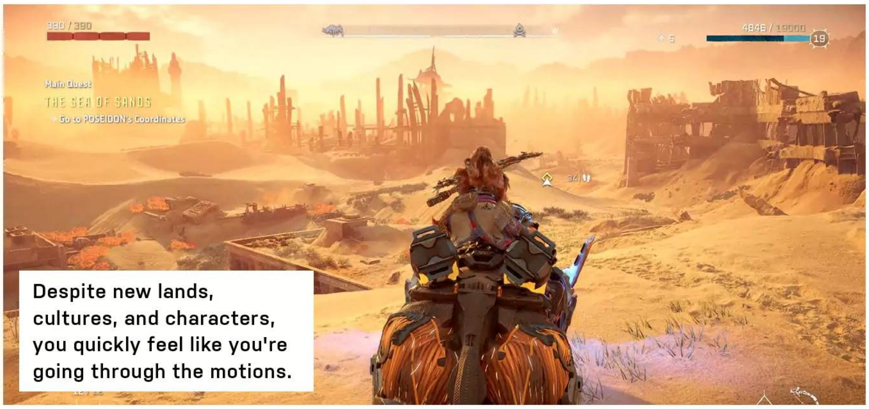
While the climbing controls enabling Aloy to scrabble and leap around the world are now much more naturalistic than the very linear maneuvering in the first game, it sometimes conflicts with the gorgeous graphics. There's so much visual noise that it can be hard to parse points of interaction. Some surfaces are fully climbable, while others aren't. Prepare, therefore, to hit the scan button a lot to have Focus highlight what you can grab.

Other upgrades are more perfunctory. Besides being one of the slowest and most prescriptive grapples in gaming, the pullcaster also allows you to open specific vents and pull down walls. The igniter allows you to blow open different, marked walls. The vine cutter allows you to destroy ivy covering, you guessed it, specific doors and walls. The diving mask fares better, as some areas have some rather pretty, if basic, underwater exploration.

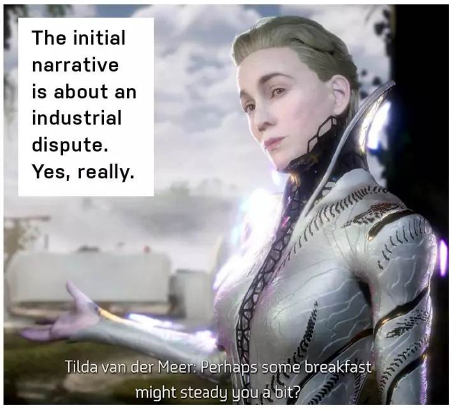
Still, for all the jumping around and the open world, *Horizon* is a third-person shooter at heart, built around some wonderfully handcrafted weaponry. There's a real tactility to combat, especially when you fight the big mechanical creatures, and even returning weapon types have been given fresh forms. Each mode of fire gets its own slot on the weapon wheel now, meaning that your five pieces of gear can in practice feel like 10.

It's a shame, then, that so much of *Forbidden West* focuses on enemies

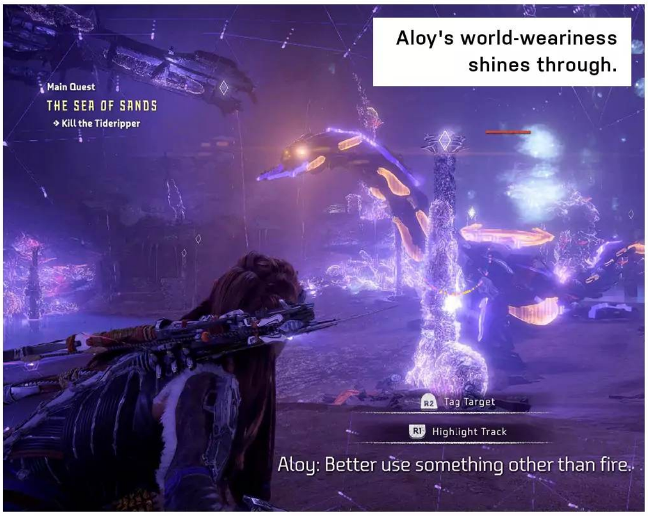
© SONY INTERACTIVE ENTERTAINMENT/GUERRILLA GAMES


390 / 390
4846 / 13000
19
Main Quest
THE SEA OF SANDS
Go to POSEIDON's Coordinates

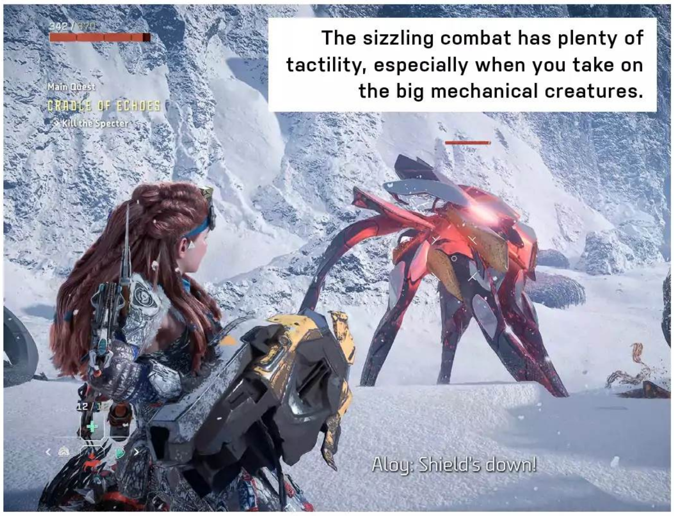
Despite new lands, cultures, and characters, you quickly feel like you're going through the motions.


Tilda van der Meer: Perhaps some breakfast might steady you a bit?

The initial narrative is about an industrial dispute. Yes, really.


Main Quest
THE SEA OF SANDS
Kill the Tideripper
R2 Tag Target
R1 Highlight Track
Aloy: Better use something other than fire.

Aloy's world-weariness shines through.


342 / 370
Main Quest
CRADLE OF ECHOES
Kill the Specter
Aloy: Shield's down!

The sizzling combat has plenty of tactility, especially when you take on the big mechanical creatures.

besides the series' iconic robosaurs. The slicker sci-fi elements introduced in the story give rise to some smooth and utterly dull plastic robots and legions of annoying human guards. The final boss fights, including those in the DLC, are likewise just dudes with mech suits or futuristic armor, and they lack the series' distinctive flavor. All told, then, the rollicking machine combat ends up being only a small part in a pretty boring world. Ultimately, *Forbidden West* struggles to keep up with other, better open worlds, and as desperately as it tries, this sequel simply can't recapture the *Zero Dawn* magic. –OSCAR TAYLOR-KENT

VERDICT
7

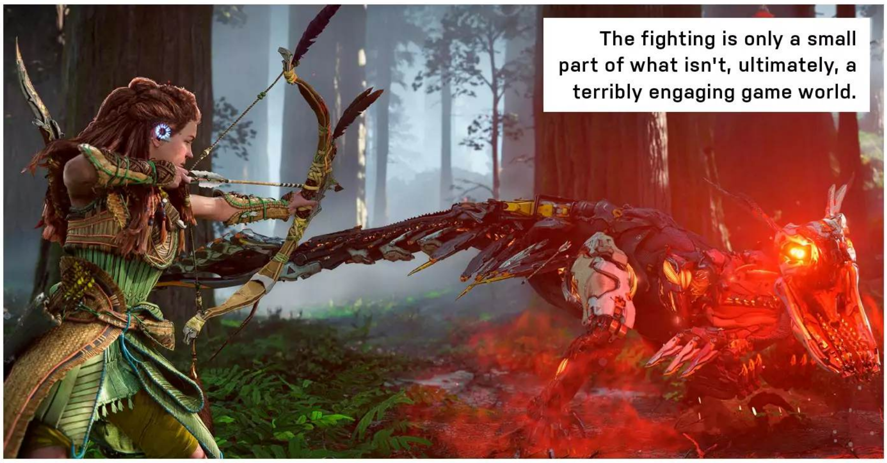
Horizon: Forbidden West

MACHINE CODE
Stunning visuals; Rollicking and tactile combat.

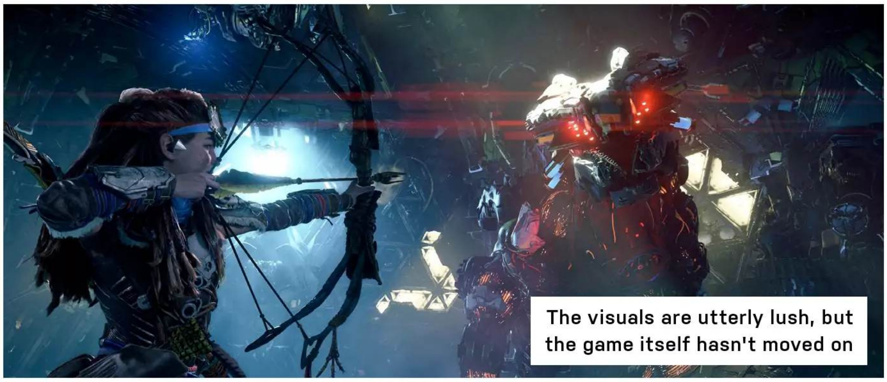
GHOST IN THE MACHINE
Frustrating narrative; Can't recapture that *Zero Dawn* magic.

RECOMMENDED SPECS CPU, Intel Core i5-8600 or AMD Ryzen 5 3600. GPU, NVIDIA GeForce RTX 3060 or AMD Radeon RX 5700. RAM, 16GB.

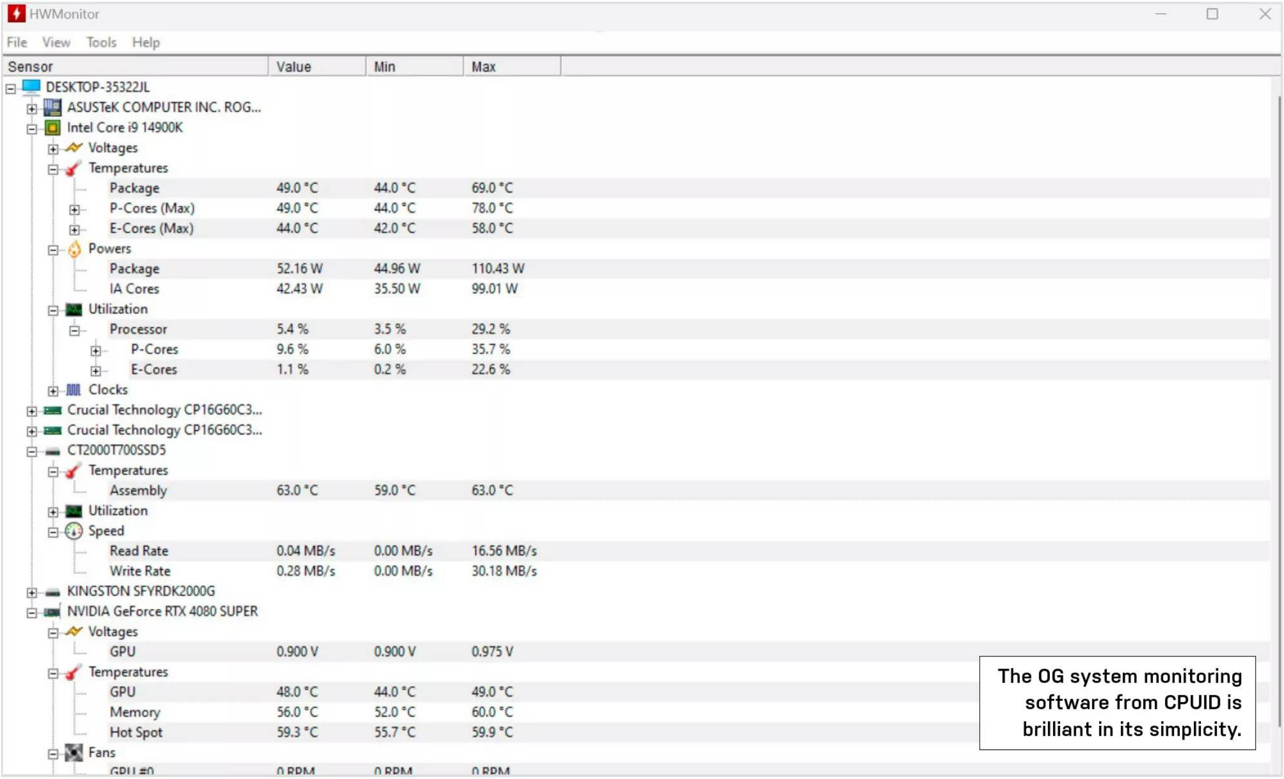
$59.99, www.guerrilla-games.com, rated Teen



The fighting is only a small part of what isn't, ultimately, a terribly engaging game world.



The visuals are utterly lush, but the game itself hasn't moved on



```
Sensor                              Value        Min          Max
DESKTOP-35322JL
  ASUSTeK COMPUTER INC. ROG...
  Intel Core i9 14900K
    Voltages
    Temperatures
      Package                       49.0 °C      44.0 °C      69.0 °C
      P-Cores (Max)                 49.0 °C      44.0 °C      78.0 °C
      E-Cores (Max)                 44.0 °C      42.0 °C      58.0 °C
    Powers
      Package                       52.16 W      44.96 W      110.43 W
      IA Cores                      42.43 W      35.50 W      99.01 W
    Utilization
      Processor                     5.4 %        3.5 %        29.2 %
        P-Cores                     9.6 %        6.0 %        35.7 %
        E-Cores                     1.1 %        0.2 %        22.6 %
    Clocks
  Crucial Technology CP16G60C3...
  Crucial Technology CP16G60C3...
  CT2000T700SSD5
    Temperatures
      Assembly                      63.0 °C      59.0 °C      63.0 °C
    Utilization
    Speed
      Read Rate                     0.04 MB/s    0.00 MB/s    16.56 MB/s
      Write Rate                    0.28 MB/s    0.00 MB/s    30.18 MB/s
  KINGSTON SFYRDK2000G
  NVIDIA GeForce RTX 4080 SUPER
    Voltages
      GPU                           0.900 V      0.900 V      0.975 V
    Temperatures
      GPU                           48.0 °C      44.0 °C      49.0 °C
      Memory                        56.0 °C      52.0 °C      60.0 °C
      Hot Spot                      59.3 °C      55.7 °C      59.9 °C
    Fans
      GPU #0                        0 RPM        0 RPM        0 RPM
```

The OG system monitoring software from CPUID is brilliant in its simplicity.

HWMonitor vs HWiNFO

The kings of system monitoring go head-to-head

AH, THESE TWO TITANS. If you've spent any amount of time in the world of benchmarking, stress-testing your PC, or even if you're just curious about how toasty that Ryzen 9 7950X is getting, you'll have no doubt heard of HWMonitor and HWiNFO.

On the surface, they serve a very similar purpose. Their job, as much as it is, is to tie into the mass of sensors that litter your motherboard and supporting components, reporting on all manner of temperatures, voltages, and clock speeds that your OS and system need to know about. At this point, they then relay that information directly back to you in an easily readable format.

Now. it goes without saying that here at *Maximum PC*, we are big fans of both of these pieces of software. Over the years, we've swung back and forth between the two, as they both serve a very similar purpose, but both provide a unique array of features that can help or hinder any avid tech journalist. In fact, some manufacturers often recommend one over the other due to more accurate reporting from time to time.

Okay, we'll admit that it's not exactly the most exciting of head-to-heads out there, but the question still needs asking: which one do you pick over the other? Which one is better from a purely objective point of view?

HWMONITOR

Arguably the far better known of the two, HWMonitor's lineage lies with CPUID, the same folk who brought you CPU-Z. There are two core variants available: a full 32/64-bit installer version, and a portable zipped version, depending on what you need. On top of that, there's also a Pro licensed edition, but we'll talk a little bit more about that on the opposite page..

HWMonitor is incredibly easy to use, and that's no bad thing. Upon opening the app, you're bombarded with a long list of sensors, all reporting different stats and figures from all the components in your PC, handily labeled and listed for your convenience. In our case, we use it predominantly for monitoring temperatures, utilization, and clock speeds, particularly during benchmarking runs, to see just how well products tick.

You can close each sub-heading or component with a click on the menus, or expand them respectively. But it's a fairly basic system, and won't remember what you've closed or opened for next time.

Options are limited to just being able to adjust your temperature measurements, and that's about it. There's a reset button to flatten out your current value, and the min/max values as well. It also has a 'dark theme', but it's more gray than dark.

As for system resource use, you're looking at around 32MB on Windows using the installed version, and between 0.2 and 0.4 percent CPU usage under load.

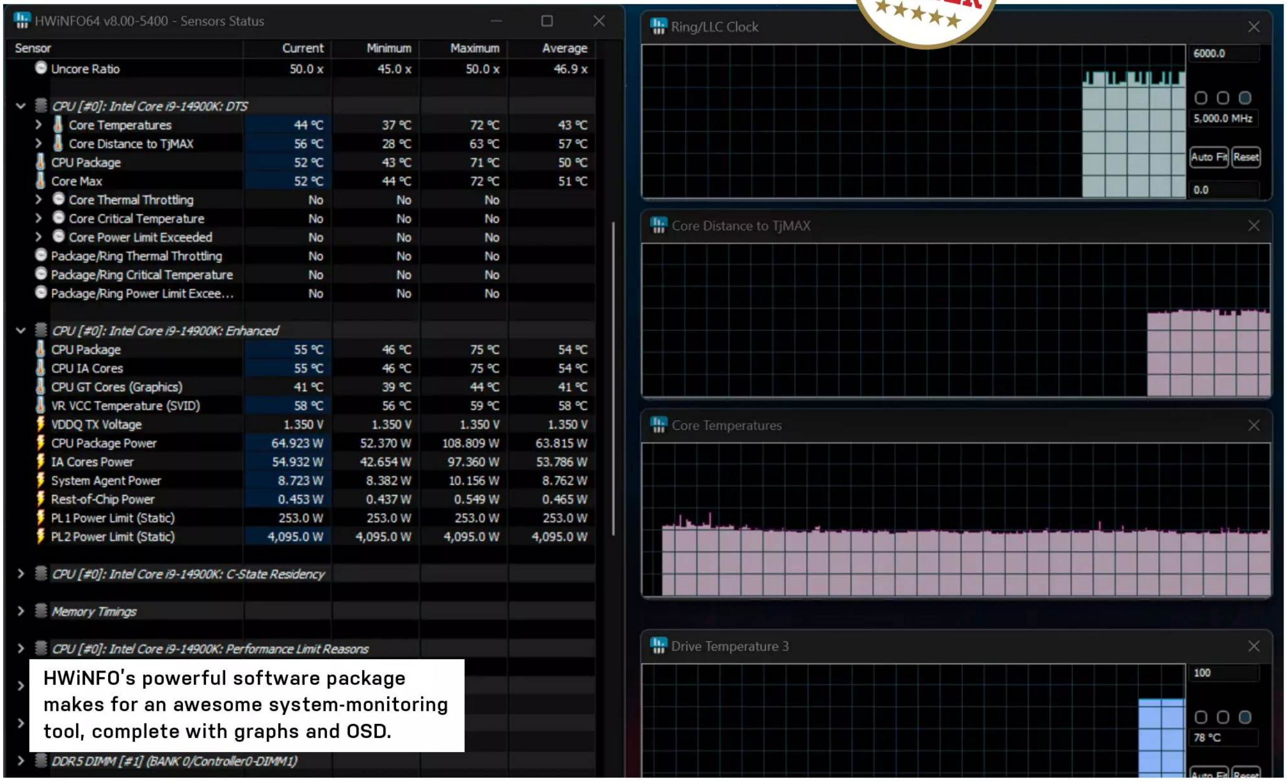
HWINFO

As for HWiNFO, it's certainly the lesser known of the two, but far more advanced in its configuration. The range of sensors is huge in comparison to HWMonitor—far too many for us to list here, but all the ones we use on the day-to-day are well taken care of.

As standard, it's considerably less dumb than HWMonitor, remembering what threads you've closed, and which

© HWMONITOR

HEAD TO HEAD WINNER



Sensor	Current	Minimum	Maximum	Average
Uncore Ratio	50.0 x	45.0 x	50.0 x	46.9 x
CPU [#0]: Intel Core i9-14900K: DTS				
Core Temperatures	44 °C	37 °C	72 °C	43 °C
Core Distance to TjMAX	56 °C	28 °C	63 °C	57 °C
CPU Package	52 °C	43 °C	71 °C	50 °C
Core Max	52 °C	44 °C	72 °C	51 °C
Core Thermal Throttling	No	No	No	
Core Critical Temperature	No	No	No	
Core Power Limit Exceeded	No	No	No	
Package/Ring Thermal Throttling	No	No	No	
Package/Ring Critical Temperature	No	No	No	
Package/Ring Power Limit Excee…	No	No	No	
CPU [#0]: Intel Core i9-14900K: Enhanced				
CPU Package	55 °C	46 °C	75 °C	54 °C
CPU IA Cores	55 °C	46 °C	75 °C	54 °C
CPU GT Cores (Graphics)	41 °C	39 °C	44 °C	41 °C
VR VCC Temperature (SVID)	58 °C	56 °C	59 °C	58 °C
VDDQ TX Voltage	1.350 V	1.350 V	1.350 V	1.350 V
CPU Package Power	64.923 W	52.370 W	108.809 W	63.815 W
IA Cores Power	54.932 W	42.654 W	97.360 W	53.786 W
System Agent Power	8.723 W	8.382 W	10.156 W	8.762 W
Rest-of-Chip Power	0.453 W	0.437 W	0.549 W	0.465 W
PL1 Power Limit (Static)	253.0 W	253.0 W	253.0 W	253.0 W
PL2 Power Limit (Static)	4,095.0 W	4,095.0 W	4,095.0 W	4,095.0 W
CPU [#0]: Intel Core i9-14900K: C-State Residency				
Memory Timings				
CPU [#0]: Intel Core i9-14900K: Performance Limit Reasons				
DDR5 DIMM [#1] (BANK 0/Controller0-DIMM1)				

HWiNFO's powerful software package makes for an awesome system-monitoring tool, complete with graphs and OSD.

sensors you've paused or don't want to see, ready for the next time it's opened. It also comes with active logging and a host of graphing tech built in (simply right-click on a sensor, and you can generate a live graph for that spec).

You also get OSD support as standard, although it is limited to just five additions without a Pro license attached. On top of that, third-party add-on support is rife, so if you're running a keyboard with a display, or something like a Stream Deck, there's support for that here, too. On top of that, it's a minor detail, but Dark Mode is tied to your OS theme. You can even add sensor data as icons to your bottom-right Windows toolbar.

There's a lot to love here, and it's far more vast a software setup than the base HWMonitor variant, but that does take up resources. In our testing, it used around 64MB of memory in total, and averaged 0.4 percent CPU usage during test runs, although we did see the occasional spike to two percent.

LICENSES LICENSES

Both also feature different paid versions. HWMonitor, has a Pro variant as well, which is a slightly juiced-up variant of the standard HWMonitor, more in line with HWiNFO. You can download that for free, and you'll get a 30-day trial on first install, after which you'd need a license key. As standard, the basic license comes in at €20 ($21.40) and grants you a lifetime Pro license, plus one year of updates for HWMonitor Pro, along with a maximum of 10 remote connections to your device (for monitoring your rig, er, remotely). Alternatively, you can pay €35 ($37.50) and get a two-year update license, with 20 remote connections. If you don't renew, your licensed version will still work, but you won't be able to update it, so if you equip new hardware, say a Ryzen 9 10950X, it likely won't register in the program without that update.

On the other side of the fence, HWiNFO also features a number of licenses. A perpetual license, for $129 that grants you lifetime updates, at no extra cost, along with a subscription model that's similar to HWMonitor, with a $29 up front permanent cost, along with $14.50 yearly renewal cost for continued updates.

It's worth noting, however, that HWiNFO's Pro features are far more advanced, including auto reporting via command line, shared memory support, unlimited OSD items, and expansive remote monitoring (with a maximum of 50 connections).

At their core, both programs deliver some seriously useful sensor-logging capabilities. If all you need is a quick glance at a temperature every now and then, HWMonitor is the way to go. Its super-sleek interface and no-frills design make it an ideal pick for anyone who just needs to keep an eye on things every now and then. HWiNFO, even in its base form, is far more complicated, but far more powerful because of it. If you're looking to analyze the ins and outs of every facet of your machine, it's the one to go for. Pro licensing for both amps up the feature sets, but it's arguable that if you're looking at the Pro license for HWMonitor, you might be better off saving cash and grabbing HWiNFO instead. **–ZAK STOREY**

VERDICT
9

HWMonitor

+ MONITOR THIS! Simple and effective low-resource usage.

– A TN PANEL Basic license is lacking; Pro license doesn't make much sense.

Free / Starting from €20, www.cpuid.com

VERDICT
9
KICK ASS!

HWiNFO

+ KNOWING IS HALF THE BATTLE Insane level of configuration; Awesome sensor array; Dark mode is great; Free version is basically Pro HWMonitor.

– HARD...WEAR AND TEAR Resource use higher because of feature set; Can be intimidating.

Free / Starting from $29, www.hwinfo.com

© HWINFO

LETTERS

WE TACKLE TOUGH READER QUESTIONS ON...

> Workstations, please!
> High scores
> OLED fears

Next-gen number crunchers

I'm the guy who suggested building the 'number crunching monster' rig that appeared in your October 2020 issue. You went with the AMD Threadripper 3970X for that build, which was awesome! Now that several years have passed, I was wondering whether you'd be interested in building an updated kick-ass business workstation, but with Team Blue (Intel) this time?

In particular, I'd love to see a build using one of Intel's Sapphire Rapids-WS Xeon W processors. Although the Xeon W-3400 product line is quite impressive, maybe something from the Xeon W-2400 product line would be a more reasonable choice budget-wise. Anyhow, I sure hope lightning does strike twice so I can see another non-gaming build in your pages!

–V. Thompson

EDITOR-IN-CHIEF, GUY COCKER, RESPONDS: Thanks so much for your letter, which makes a fair point that we haven't done a high-end workstation build in a while. First of all, that's a great idea—these kind of PCs have evolved massively over the last few years, as working from home has become a priority for many. But the main driver has been AI making its way into every facet of work, from commerce and education to scientific research. As such, more and more organizations are equipping themselves with workstations than ever before, while those who have been using them for decades have seen their power demands increase.

Now, I should say that this isn't an area that I'm personally experienced with—my background is in consumer technology, so home and gaming use is where I tend to gravitate. However, I have been invited to a couple of Lenovo ThinkStation briefings, and have enjoyed learning about how they put their P Series workstations together, and how they're used for all sorts of professional uses. They also look the part as well, with thermal design co-developed with Aston Martin.

But I digress. I'll talk to our builder, Zak Storey, about such a build. We're grateful for your idea, to be honest, because in the second half of this year it looks like there'll be a dearth of new GPU releases, and we'll be on the lookout for other themed builds. We're lining up the RX 7900 GRE for next issue, but keep an eye out for a future issue when we'll hopefully have something more workstation-oriented!

You also mentioned using Intel's Xeon processors, of which Intel has just announced a new generation. Head to page 8, where you'll see the new Xeon 6 chips leading the news section.

Metric mayhem

I've been a subscriber since the time of Boot, and I would like to make a small editorial suggestion. I don't know what the percentage of your readers reside in the United States, but I would imagine that it a fairly substantial number. 854 grams or 640 grams means absolutely nothing to me, or most likely to any other reader in this country. Neither do measurements in mm, cm, meters, or any other metric unit. If you want to print a weight in grams, please also include the weight in ounces, pounds, etc. For example, in your recent review of the Lenovo Legion Go, change the sentence to read "...so the Go's 854 grams (30.1 oz) with controllers or 640 grams (22.5 oz) without..." This would make for a much more informative review, at least for people in the US. It is strange—sometimes you use inches for measurements of cases; sometimes you use mm.

Also, I think it would be beneficial to have a short article describing your review scores. In the past, a '6' meant that the product did what it was supposed to do but the writer had no idea why anyone would desire to purchase it. For the past several years, I have not seen a review with a score lower than a 6. In several issues, I believe that every review had a score of 8. That's fine, but if the readers don't know what your scoring system is, the numbers don't mean anything.

↘ submit your questions to: editor@maximumpc.com

Thank you for your consideration. **–J. Croft**

EDITOR-IN-CHIEF, GUY COCKER, RESPONDS: Thank you for your suggestions both on the units of measurement and the scoring system we use here on *Maximum PC*! I can feel the frustration in the lack of inches and lbs in these pages, and it's something I will talk to our production editor about to make sure no one's missing out, no matter where they are in the world!

We do have a worldwide readership, especially as the magazine is distributed electronically through platforms like Readly and Pocketmags. However, our heritage is as a magazine for the US market, hence our prices being in US dollars and release dates referring to US availability. There are exceptions, of course, like one machine in our AI PC feature this month only being available in the UK & Ireland, but for the most part, we're thinking US first—something we clearly need to address when it comes to measurements! So apologies again for the inconsistency there.

Your scoring enquiry requires a more nuanced answer, however. You're right, we don't have a breakdown of what each score means—our sister title, *PC Gamer*, runs a detailed explanation on the opening spread of its reviews section each issue. Our scoring system, for those that don't know, runs from 0-9 'Kick Ass', with the latter being the highest score we give any product. This is a decision from before my time, the idea being that there's no such thing as a 'perfect 10'. This is an idea I subscribe to, having spent 24 years reviewing consumer tech and video games. I think most of the other scores speak for themselves, but as editor, I do try to make sure the score lines up with the text when I'm editing. If they don't match, I go back to the writer and ask them to adjust the text, score, or sometimes both, accordingly.

In terms of seeing higher-scoring reviews recently, this is something that I've tried to be more conscious of. In my opinion, part of the magazine's job is to tell you about the products you need to be looking at or be aware of in order to improve your PC-using experience. As fun as it can be to read (and indeed, write) a review of a truly terrible product, I'd much rather you be kept up to date with the best of the best. That means sometimes not including a review of a product that we think in't worth your time, or covering it elsewhere in the magazine, such as Lab Notes. Of course, the big CPU and GPU releases will always be reviewed, but if we can highlight a great product that you might not have known about (like the Elgato Facecam MK.2, in this issue on page 87), then I'd much rather we do that than one that shouldn't even be on your shortlist.

We have run a lot of high-scoring reviews recently, including a couple of 9 Kick Ass awards this issue alone. We always compile these "Best of the Best" products into our Gear of the Year feature in each Holiday issue we do (released at the beginning of December)—this year's list looks like it will already be an abundance of riches!

Seeing ghosts

I often read in these pages from both you and Jeremy Laird extoling the virtues of an OLED panel as a gaming display. I'm starting to get more interested now that it's not just Dell and LG making these monitors, as it means they're coming in different screen sizes, curves, and ratios, while the competition drives prices down.

Our last workstation build, from nearly four years ago.

However, I cannot get over my fear of OLED burn-in, having been an early adopter of an OLED TV and suffering from this myself. Basically, my child would often play games after school (when I wasn't around) and would be fond of pausing his games console and going away to do something else, leaving the image to get etched on the screen.

How much of a problem is this on OLED monitors, and should I be this worried about it? **–T. Mulvern**

EDITOR-IN-CHIEF, GUY COCKER, RESPONDS: Your question is well timed, as this is the exact topic of Jeremy's Lab Note (page 72) in this issue. As unbeatable as OLEDs are for gaming (and I'm typing this using one right now), they aren't the best for general use. The text isn't as sharp as on the best IPS panels, although that could be the fact that my OLED is 1440p, not 4K. But by far the most frustrating part of owning one is the Pixel Refresh message that appears every few hours, which does prevent burn-in, but is impractical to do during a working day.

Jeremy brings this up in his column this month, as well as the issue of warranty. Most new panels come with a comprehensive three-year warranty to help this issue, but then, there's a practical problem if you have to return an affected monitor and then wait for a new one, as well as what to happens beyond that three-year time frame.

I personally would never go back from having an OLED now, but they do sadly still come with some pretty big caveats. ⏻

THE BUILDS

THIS MONTH'S STREET PRICES...

BUDGET

THERE AIN'T NO stopping the turning of the worlds, and the same is true of our Blueprints. This issue, we've seen some significant changes across the board, including a revamp of our mid-range build to be a little less ambiguous, and a little more, er, mid-range. Yep, that's right. And what's triggered all this? Escalating prices, that's what. Those pesky manufacturers are at it again, and supply and demand has shifted its attention away from the launch of Nvidia's new Supers and solely on the SSD market.

Our budget builds were first on the block, and saw some significant price bumps, particularly across the motherboard and GPU segments. Although not quite as drastic as some of the shifts in the Mid-range and Turbo builds, the value of the $ dramatically changes when you have less of it. That's certainly true when it comes to budget PC builds, that's for sure.

To counteract—and in some ways pre-empt—the shifting SSD market, we've been a bit radical with both systems' storage solutions, downgrading our primary SSD from a 1TB PCIe 4.0 to a 512GB variant. For our backup storage, we've shifted to a 1TB PCIe 3.0 SSD instead. It may be slower than a 4.0 drive, but this does give us $45 worth of savings. 512GB is plenty for an OS, and although a little frugal, 1TB of (still super quick) SSD storage for your games and files as a backup drive is more than manageable.

We've also changed both motherboards down a chipset or so. Gigabyte showed us this issue that we shouldn't just write off that second-tier chipset straight out of the gate, and we've taken that to heart, moving our AMD build to the Gigabyte B650 UD AC, and the Intel system over to ASRock's B760 Pro RS, both of which have shifted the pricing on these systems quite dramatically.

All in all, we've brought the AMD build down by another $59 on last issue, and Intel by $53 (finally bringing it sub-$1,000) all without sacrificing a huge amount on performance. Nice.

AMD INGREDIENTS

PART		PRICE
Case	Corsair 4000D Airflow	$95
PSU	600W Thermaltake Toughpower GX2 80+ Gold	$68
Mobo	Gigabyte B650 UD AC ATX **NEW**	$165
CPU	AMD Ryzen 5 7600	$194
GPU	ASRock Challenger D Arc A750 8GB	$200
RAM	16GB (2x8GB) Kingston Fury Beast RGB @ 6000 C36	$70
SSD 1	512GB ADATA Legend 840 PCIe 4.0 M.2 **NEW**	$45
SSD 2	1TB MSI Spatium M371 PCIe 3.0 M.2 **NEW**	$59
OS	Windows 10 Home 64-bit OEM (Windows 11 Compatible)	$32
Approximate Price:		**$928**

INTEL INGREDIENTS

PART		PRICE
Case	Corsair 4000D Airflow	$95
PSU	600W Thermaltake Toughpower GX2 80+ Gold	$68
Mobo	ASRock B760 Pro RS ATX **NEW**	$150
CPU	Intel Core i5-14400	$210
GPU	ASRock Challenger OC RX 7600 8GB	$260
RAM	16GB (2x8GB) TeamGroup Elite Plus DDR5 @ 4800 C40	$53
SSD 1	512GB ADATA Legend 840 PCIe 4.0 M.2 **NEW**	$45
SSD 2	1TB MSI Spatium M371 PCIe 3.0 M.2 **NEW**	$59
OS	Windows 10 Home 64-bit OEM (Windows 11 Compatible)	$32
Approximate Price:		**$972**

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TAKE IT FROM A GEEK.SM

MID-RANGE

BOY, HAS THIS issue been a doozie for our mid-range spec. First, let me read off some stats. For our AMD build, the mobo increased in price by $50, the CPU by $25, RAM by $13, and SSD by $12. For Intel, the CPU went up by $15, the cooler by $20, the GPU by $20, RAM by $18 and SSD by $12. What a mess.

With those colossal shifts in mind, we decided to rip the guts out of these machines and pitch them at an entry-level 4K/top-tier 1440p build instead, with a $1,500 price point as the target. That meant shifting both GPUs around, running the 7800 XT in our AMD build, and the 4070 Super (in all of its painfully expensive glory) in our Intel rig. We've paired that with a doubling of storage for our secondary drive, too. 2TB, is let's be honest, the absolute sweet spot right now for gaming. You can chuck a ton on it, and not have to worry about space at all. MSI's Spatium fits the bill perfectly for that role.

For build-specific elements, we desperately wanted to change out the 7700 in our AMD build, as the $25 price hike sucked, but, without changing to either the far lesser-powered 7600X or the far more expensive 7800X3D, we were out of luck. To offset that, we've gone with a slightly different motherboard this issue, which has saved us a good $39, and shifted our RAM over to the Corsair Vengeance kit, as it's dropped from $115 to $79.

For our Intel build, we've changed both the CPU and its cooler. Opting for an Intel Core i5-14400F will reduce our core count, but performance should still be fairly potent, and it saves us a good $84 in the process. Combine that with a near $50 saving on the CPU cooler as well, and we're onto a winner, offsetting that extra $170 additional cost front-loaded by picking the RTX 4070 Super.

That leaves us with a $145 price increase for our AMD system, and a $223 price increase for the Intel rig, but better 4K gaming potency, and some seriously tasty secondary storage as well.

AMD INGREDIENTS

PART		PRICE
Case	NZXT H7 Flow	$107
PSU	850W Thermaltake Toughpower GF1 2024 80+ Gold	$95
Mobo	Gigabyte X670 Gaming X AX V2 - AM5 **NEW**	$210
CPU	AMD Ryzen 7 7700	$285
Cooler	Corsair A115 Air Tower	$100
GPU	PowerColor Hellhound OC RX 7800 XT **NEW**	$480
RAM	32GB (2x16GB) Corsair Vengeance @ 6000 C36 **NEW**	$79
SSD 1	1TB Corsair MP600 PRO LPX M.2 PCIe 4.0	$90
SSD 2	2TB MSI Spatium M482 M.2 PCIe 4.0 SSD **NEW**	$109
OS	Windows 10 Home 64-bit OEM (Windows 11 Compatible)	$32
Approximate Price:		**$1,587**

INTEL INGREDIENTS

PART		PRICE
Case	NZXT H7 Flow	$107
PSU	850W Thermaltake Toughpower GF1 2024 80+ Gold	$95
Mobo	MSI Z790 Gaming Pro WiFi ATX	$189
CPU	Intel Core i5-14400F **NEW**	$210
Cooler	Enermax Liqmax III 360 ARGB **NEW**	$83
GPU	Zotac Twin Edge RTX 4070 Super **NEW**	$590
RAM	32GB (2x16GB) Corsair Vengeance DDR5 @ 6000 36	$79
SSD 1	1TB Corsair MP600 PRO LPX M.2 PCIe 4.0	$90
SSD 2	2TB MSI Spatium M482 M.2 PCIe 4.0 **NEW**	$109
OS	Windows 10 Home 64-bit OEM (Windows 11 Compatible)	$32
Approximate Price:		**$1,584**

TURBO

WHAT A WEIRD WORLD we live in, where both our budget and mid-range systems have undergone some serious surgery in order to try and maintain the same level of price and performance. Yet, the higher up the chain you go in terms of both budget and performance parts, the less change actually occurs. It's just the way these things work out.

Okay, let's be honest. The biggest profit margins lie with these top-tier parts. Sales volume is higher in the entry-level and mid-range, sure, but it's the high-end kit that has the most insulation when it comes to taking price hits. This is speculative, of course, but it certainly seems to be the most likely cause here.

First then, the good news. The RTX 40 Super series crisis seems to be over. Stock is readily available, and our PNY 4080 Super of choice has fallen (yes, fallen) in price by $50, and is available for purchase today. It only took an entire quarter for Nvidia's foundries to pump out enough GPUs and the scalpers to lose interest. Otherwise, we've seen some tasty price drops across the board on both our systems. The AMD rig had its CPU price fall by $50 and GPU by $30. Memory had to be swapped out, as it would be bumped up by an impressive $35, and, similarly to our mid-range builds (and because we're getting bored of tiny screens on CPU coolers), we've gone for a slightly 'lower' spec 360mm AIO. We're using air quotation marks there because really, performance is going to be identical—you just won't have a fancy screen to display Gifs on.

Likewise, our Intel build saw price drops across a number of parts, and we've gone ahead and again changed out the cooler to a Phanteks Glacier One, saving us a ton of cash on NZXT's $277 360mm AIO. Interestingly, SSD pricing across both these drives has remained resolutely concrete for some time. They are both using 232-layer TLC NAND flash from Micron, so we are wondering whether AI might not like high-density flash or not. It could be that, or because there's an excess of PCIe 5.0 drives floating around in the ether.

AMD INGREDIENTS

PART		PRICE
Case	Phanteks Enthoo Pro 2 Tempered Glass	$150
PSU	Super Flower Leadex Platinum SE 1200W - 80+ Platinum	$145
Mobo	Asus Prime X670E Pro WiFi - AM5	$300
CPU	AMD Ryzen 9 7950X	$549
Cooler	Asus ROG Ryuo III 360 ARGB 360mm AIO **NEW**	$190
GPU	Sapphire Nitro+ RX 7900 XTX 24GB	$1,000
RAM	64GB (2x32GB) TeamGroup T-Create Expert @ 6000 C34 **NEW**	$185
SSD 1	2TB Corsair MP700 PCIe 5.0 M.2	$249
SSD 2	2TB Crucial T500 PCIe 4.0 M.2	$155
OS	Windows 10 Home 64-bit OEM (Windows 11 Compatible)	$32
Approximate Price:		**$2,955**

INTEL INGREDIENTS

PART		PRICE
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PSU	Super Flower Leadex Platinum SE 1200W - 80+ Platinum	$145
Mobo	Gigabyte Z790 Aorus Elite AX-W ATX	$367
CPU	Intel Core i9-14900KF	$531
Cooler	Phanteks Glacier One 360D30 360mm AIO **NEW**	$180
GPU	PNY Verto Overclocked RTX 4080 Super 16GB	$1,000
RAM	48GB (2x 24GB) G.Skill Ripjaws DDR5 @ 6400 CL36	$150
SSD 1	2TB Corsair MP700 PCIe 5.0 M.2	$249
SSD 2	2TB Crucial T500 PCIe 4.0 M.2	$155
OS	Windows 10 Home 64-bit OEM (Windows 11 Compatible)	$32
Approximate Price:		**$2,959**

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